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THE TEACHER'S

MANUAL OF GEOGRAPHY

I. *HINTS TO TEACHERS*

II. *MODERN FACTS AND ANCIENT FANCIES*

BY

JACQUES W. REDWAY

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A SERIES OF GEOGRAPHIES, DESCRIPTIVE, POLITICAL, AND PHYSICAL.

A GEOGRAPHY OF PENNSYLVANIA.

A GEOGRAPHY OF MASSACHUSETTS, CONNECTICUT, AND RHODE ISLAND.

STUDIES IN PHYSIOGRAPHY (*In Press*).

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PREFACE.

THE suggestions offered in the following Manual have been prompted by experience in the school-room, as well as by that of exploration and travel. They are intended as a supplement, and not as a substitute, for the ordinary work of the teacher. They will be of no avail whatever where the only aim in the study of geography is the preparation for examination. I have thought it unnecessary to present any graded course of study. The admirable work of Professor Frye, 'Child and Nature,' leaves in that direction nothing to be desired. Mr. Nicholl's 'Topics in Geography' will also be found a most useful companion.

In the second part of the Manual I have considered some of the traditions of geography, in the light of modern science. Some of the discussions have not previously been published; and much of the material has been drawn from sources that to most educators are not readily available.

I am not of the opinion that the average teacher needs pedagogical regeneration; on the contrary, I believe that less energy devoted to improvement of methods, and a little more to the quality of the material taught, would not be amiss.

Acknowledgments are due to Miss E. M. Reed of the Training School, Springfield, Mass., for many valuable hints in the preparation of this work.

J. W. R.

PART I.

HINTS TO TEACHERS.

I.

PRELIMINARY ORAL WORK.

It is hardly an exaggeration to say that the average child learns more of the science of geography in his rambles out of doors, before beginning the study in his school course, than he learns from the text-book after his school work in that study begins. The reason is that, in the one case he reads geography in nature, in the other from the printed page. No matter how well and how faithfully the teaching may be done, the disadvantages arising from the use of words and sentences instead of things in nature, are too great to be easily swept away. Within a few years the importance of this fact has been so widely recognized by primary teachers that, in a majority of schools, text-book work has been largely abandoned in primary grades, and oral lessons, aided by the moulding-board and the study of natural forms, have very properly taken its place.

The outline of the following course in oral primary geography was furnished at the author's request by Miss Mathilde E. Coffin, of the Millersville, Pa., State Normal School, as a basis for the preparation of this and the following chapter. It is intended as a list of topics for oral work rather than a systematic course of study. Much of the work discussed must necessarily be done out of doors. Children who like to make 'mud pies' will take equal delight in modelling natural forms in sand or in clay. Time ordinarily spent in aimless rambling will be gladly devoted to the collection and study of natural objects when once there is an incentive for it. In ungraded country schools the wise plan of keeping primary pupils out of doors at all times when they are not engaged in recitation

is an excellent one, and these are the golden hours which the child may devote to the study of nature. The out-of-door work should of course be supplemented by the necessary developmental exercises, and lessons in oral expression in the school-room. Bear in mind, also, that while recitation-hearing is an easy matter, teaching children how to study and how to observe is a qualification demanding the highest capabilities of the teacher.

Form. — It is well, so far as possible, to acquire a knowledge of form from natural objects. Fruit, crystals, forms of leaves, shells, animals, and geometric forms will all furnish instructive lessons. At first the work must be wholly imitative, but, as skill is acquired, objects may be modelled from memory. With the modelling of geometric forms comes the necessary instruction in the use of descriptive terms, such as plane, curved, level, cubic, spherical, square, circular, slanting, vertical, angle or corner, solid, horizontal, etc. Inculcate with every step ideas of neatness in work and faithfulness to the copy.

Size. — Teach by actual measurement all the units of linear measure within the comprehension of the pupil. The latter should be taught to estimate the inch, foot, and yard with the eye. It will be found rather more difficult to estimate vertical than horizontal distances, especially if the eyesight be at all astigmatic. It is well to have a pupil learn the length of his ordinary step, so that he can pace either a rod or one hundred feet with reasonable accuracy. It is not a difficult matter to estimate a distance of one mile, but the estimate would better be made by reckoning the time required to walk it, rather than by the number of steps. The average adult takes about two thousand steps to the mile. Three and one half miles per hour is a fair, four miles a brisk, and five miles per hour a very rapid gait. Time that is spent in estimating and measuring the dimensions of objects is by no means wasted. The ability to estimate measurements accurately has a practical value to which every person in active business life will testify. The estimation of angular distance is also an excellent drill. By subdividing an arc which measures a right angle, into halves and

thirds, almost any angle can be estimated to within two or three degrees.

Color. — The proper development of the color-sense is of no little importance to the student of nature. It is well, for many reasons, to make a special test of the color-sense of each pupil. About ten per cent of young children are deficient in color-vision. Of this proportion, some are deficient through physiological causes, others from a lack of development of the color-sense, and still others from ignorance of the names of colors. The two latter causes are remediable, and can be easily removed if the teacher will take a little extra pains with each individual pupil. Select at first, only bright, pronounced colors, and teach their names. Afterwards exercise every pupil in selecting graduated shades of each color. A pupil who is physiologically deficient in the color-sense will most likely fail in distinguishing the reds and greens. Use only well-known and standard names for the various shades and mixtures. Such names as 'ecru,' 'faded rose,' 'crushed strawberry,' etc., are whims of fancy only, and change with the fashions.

In teaching the primary colors it is best to use the classification which science has shown to be the true one, namely — *red*, *green*, and *violet*.[1]

Viewing bits of colored silk through pieces of colored glass is in many respects a useful exercise, and will be of material service in the development of the color-sense.

But the colors and the color-names that the pupil must familiarize himself most thoroughly with are those that he finds in nature. There are the various shades of red, as damask, crimson, and scarlet; the greens, as pistachio, apple-, and pea-green; the blues, as indigo, sky-, ultramarine, and cobalt-blue. There are also the various shades of lilac, pink, pearl, violet, salmon, fawn, sable or

[1] The old scheme of red, yellow, and blue holds true in mixing a few colors, but fails lamentably in the majority of cases. The trouble arises from the fact that nearly all the red, blue, and yellow pigments are *mixed* or impure colors.

seal-brown, chestnut-brown, russet-brown, iron-gray, silver-white, lemon-yellow, golden-yellow, orange-yellow, straw-yellow, tan, and a host of others, all named from objects in nature, and all standard types of color. In the light of geography these are more important than the bright spectrum colors which are so largely used in the arts. If there is any doubt that many of these colors are unfamiliar save in name, let the teacher direct half a dozen pupils to select a fawn or a pistachio shade from a collection of colors. Besides these there are the various 'lustres,' such as vitreous, pearly, metallic, etc., all used in the description of minerals.

It may be objected that lessons on color belong to the domain of physics rather than to that of geography. This is possibly true, but we must also bear in mind that color is just as much a feature of nature as is the mountain, the plain, or the valley. Moreover, it is also a means of cultivating taste, and this of itself is quite as important a factor in child-culture as the study of geography.

Locality. — The sense of the knowledge of position and direction, which is practically the 'homing instinct' of animals, is rarely developed to any great extent in mankind, and it therefore becomes a necessary part of education. Develop a knowledge of the terms right and left, and up and down. Impress the fact that these are terms relating respectively to the human body and the centre of the earth. There are various schemes for developing an idea of the position of the cardinal points, but it is well to begin at once with the direction of the north star. The direction of the sun's rising and setting will be worth incidental mention, but these should be discussed as varying and not fixed points. The direction of the shadow at noon is an excellent point to use for illustration, and the ingenious teacher can easily manufacture a sun-dial which will show the time between eight o'clock A.M. and four o'clock P.M. with reasonable accuracy. This will be found an excellent device for encouraging pupils to observe the apparent motions of the sun, both daily and yearly.

It is an excellent plan to have the points of the compass charted on a clear part of the school-room floor, or perhaps on the ceiling.

In studying the various problems under this head, the use of the map must necessarily be taken up. Begin with a map or diagram of the school-room or the school-grounds, and extend the area mapped until it includes every part of the district with which the pupil is familiar. The location of the principal surroundings should be represented approximately to a scale, and the conventional terms and signs used in chartography should be explained and used. It will be a matter of surprise to the teacher who tries the experiment, what excellent results can be obtained in these first attempts at map-drawing.

II.

OUT-OF-DOOR LESSONS FOR PRIMARY AND INTERMEDIATE CLASSES.

THE out-of-door lessons in geography, through which the child should receive his first knowledge of the forces of nature, will of necessity be confined mainly to the neighborhood in which he lives. The method in which these are conducted must depend on the judgment of the teacher as modified by surroundings. But one direction can be given: namely, make the most of what physiographical features the district affords. Supplement this by the moulding-board, and by the use of whatever pictures, models, etc., can be obtained.

Earth-Sculpture. — If the surface of the neighborhood is uneven, hilly, or rugged, the probabilities are that the unevenness has been produced by unequal weathering or else by the direct action of water. In many instances a hill is formed because its substance is harder than the rock surrounding it. So, under the action of flowing water, ice, rain, and other weathering agents, the surface is unequally worn into hills and valleys. Often there are strata of rock which show the corrasive action of running water; or perhaps soil, masses of broken rock, etc., have been carried down the slope, and spread over the valley below. By a careful search one may nearly always find marks of the forces which have thus sculptured the earth. In walking along the slope of the hill during a hard rain, one may observe the process of earth-sculpture in actual operation. The drops of rain that fall on the hill-side are clear as crystal. When they reach the bottom, however, they are loaded with fine particles taken from the soil.

Direct the pupils to observe this, and develop by skilful questioning the effect of the process when long continued.

Cover a piece of clay with sand on the moulding-table. Incline the latter slightly, and pour water on it from a sprinkler. The sand is washed away, leaving a miniature hill of clay, and the process of hill-making is thus repeated on a small scale. In a similar manner place a small piece of slate or a thin piece of rock on the sand, and apply the water. The sand is washed out under the edges a little way, but the slate protects the great mass of it, while all around the sand is carried away. In this manner one may show the formation of cliffs and certain types of table-lands.

The study of the hill will lead to that of the mountain-range. The explanation of this will be a more difficult task, because the essential feature of a mountain-range lies in the fact that it is a fold or wrinkle made by a shrinking of the earth. The following expedient has been used by the author for want of a better illustration. Take a piece of cloth-covered elastic band, ten or fifteen inches in length, and stretch it moderately. Fasten several strips of differently colored cloth to the elastic by means of mucilage, and when nearly dry, allow the elastic to slowly contract. The pieces of colored cloth will wrinkle and crumple, producing an effect which, though not a striking resemblance to mountain-folding, is nevertheless a good illustration of the manner in which plication occurred. In studying the mountain, begin with the range, as directed in p. 25.

The examples of earth-sculpture which will appeal most strongly to the child are those which are the work of running water. The little rain-formed rill which trickles along the road cuts a deep rut in one place, and spreads out in a broad channel in another. Finally it joins another rill, or else pours its current into a pool of water, which is a miniature lake or sea. When the rivulet reaches its goal, it possibly divides into several streams, forming a delta, and perhaps builds a bar opposite to its mouth.

In such a stream the pupil can see the operation of all the laws

which govern the conduct of the Mississippi or the Colorado. Develop by skilful questions, inductive and deductive, why the rill cuts a deep cañon in one place, and deposits silt in another; building its banks and bed higher than the surrounding land, and then breaking through them. Show why it forms a delta, a bar, or a spit, when it reaches its outlet. The effects of rain combined with the corrasion of running water may also be pointed out. Develop the fact that a rapidly flowing stream in a rainless region will cut deep cañons with almost vertical walls. If, on the contrary, the region is one of considerable rainfall, all the sharp, angular features will be worn and rounded in harmonious forms. This feature of erosion can be shown on the moulding-board, with the aid of a sprinkler.

It is well, also, to observe the effect of vegetation. The difference between the erosion of a grass-covered and a denuded slope is so marked that it will not fail to be observed and accounted for if the pupil's attention is called to it. Pictures of the *mauvaise terre* or 'bad-land' formation, of the Grand Cañon of the Colorado River, and of the rounded valleys of Oregon, can be made the subjects of impressive lessons. Develop the fact that vegetation is not only protective to the land, but that it also retards the collection of water in the channels which carry it off, thereby largely preventing 'freshets,' or floods.[1]

Throw a ridge of sand or mud across the channel of a rill, and make a miniature lake. By and by the basin fills, and the water runs over the lowest part of the rim. Now let the pupils observe carefully what occurs. At the inlet of the lake the current of the stream is checked, and the water begins to deposit silt, forming a little bar at the mouth. The stream issuing from the lake is likewise at work: it is cutting away the rim of the basin and lowering the level of the water. From these facts two good lessons may

[1] In Arizona and Nevada I have more than once seen a flood gather in a dry 'wash' or creek-bed so quickly, after a heavy rain, that the water rolled down the cañon almost like a solid wall. In two minutes a dry creek-bed would become an impetuous torrent. — *The Author.*

be deduced. First, that the stream flowing into a lake is always silting the basin. Secondly, the stream which flows from a lake is constantly cutting the rim of the basin lower, reducing its size, and draining the water away. These are the laws which prompted Gilbert to say, 'Rivers are the mortal enemies of lakes.'

When excursions can be made to the seacoast, impressive truths may be learned from the action of the waves. The water-worn cliffs show what can be accomplished by the continuous beating of the waves upon hard rock. The sand, examined by a magnifying glass, will show the effect of the never-ceasing surf. If one may have the fortune to visit the coast of the South Atlantic States, the long, narrow sand-spits formed by the combined action of rivers and waves, — one of which pushes the silt sea-ward, and the other land-ward, — may be made the subject of a most instructive lesson.

The different outlines of coast must not be forgotten. These will be found at the shore of almost any pond or stream of water. Indeed, the various types of coast outline may be profitably moulded at the shore if they do not occur there. Occasionally it will be necessary to obtain pictures or models of the different types, and reproduce the forms from these. Do not neglect to show that peninsulas are, in most instances, ranges of mountains extending into the sea, and that frequently a chain of islands, the partly covered summits of the range, lie beyond the point of the peninsula.

Do not neglect to instruct pupils in the application of technical names that pertain to a natural feature, and do not extemporize names where good ones already exist. The abuse of this privilege has already led to much unnecessary confusion.

Slopes. — The slopes of a body of land are commonly formed by mountain systems, but in many instances a low and almost imperceptible ridge of land separates two basins or watersheds. Steep or abrupt slopes can always be determined by the eye, and the positive slopes of the district should be invariably studied when the pupil is learning his first lessons in physical geography.

The gentle slopes of land, however, can be estimated naturally in only one way; namely, by observing the direction of the water-courses. So helpless is the eye in this respect that the most expert surveyors and topographers are often deceived. The slopes and hydrographic basins of large areas of land may be conveniently studied from both map and moulding-board. In using the map for this purpose, the boundaries of the various basins and slopes are found by drawing a light pencil-line so as to separate the sources of adjacent rivers and tributaries. In doing this the pupil will often discover the untruth of one of the oldest traditions of geography; namely, that the crests of mountain-ranges correspond with divides. A few moments' work with the pencil will show that the exception is true oftener than the rule.

Soil. — A knowledge of the various kinds of soil is not only a necessary part of the study of physical geography, but it has a practical value in education that will not be overestimated. The varieties of greatest practical use are sand, gravel, clay, and loam. Develop by observation and questioning that sand and gravel are results of running of water, and lead the pupil to discover how rough fragments of rock are converted into rounded pebbles. Do not make the mistake of teaching that the soil of deserts is composed of sand; for it is very rarely that sand is found in desert regions. Pure sand is composed of the mineral silica, and is a product of the seashore. The so-called sand of the desert may be composed of almost any kind of dry, pulverized earth.

Develop the idea that the loams are nearly always disintegrated or 'rotten' rock, finely pulverized, and mixed with decayed vegetable matter. In many instances loam has been deposited by rivers, but sometimes it has been found *in situ*. In the former case it is called *alluvial*, in the latter, *sedentary* soil. The formation of loam will be somewhat difficult of explanation, but it is not beyond the understanding of even the younger pupils. The action of the angle-, or earth-worm, which is constantly mixing and digesting rich, loamy soils within its alimentary canal, will make the subject of an excellent lesson.

In studying the properties of clay, it will be well to call attention to its imperviousness to water, and its extreme hardness when dry. Illustrate its commercial value in the manufacture of brick, pottery, etc., and its special value in holding near the surface of the earth much of the water that falls in the form of rain and snow.

Vegetation. — The first lessons on vegetable life should be of a very practical kind. The study of the germination of seeds, although hardly within the domain of geography, is an excellent exercise because it is an incentive to habits of observation. The flower-garden may be made almost as useful as the blackboard. There is no reason why the effects of heat and moisture on soil should not be as closely studied in the country school as in the higher school of learning. Almost every law which underlies the geographical distribution of plants may be illustrated in the school district.

Besides the grains, the fruits, and the vegetables of commercial value, it will be well to study the large class of plants ordinarily classed as 'weeds.' Nearly all of these have more or less value to mankind, or else they are positively baneful. A knowledge of the latter is just as important as that of the former; more especially is it necessary to learn how the seeds of the latter are distributed. The 'down' of the Canada thistle and the dandelion, and the winged seeds of the maple may be used to illustrate this.

It is a good plan to encourage pupils to collect and prepare a herbarium for the use of the school, arranging and classifying the plants of the neighborhood more with reference to their commercial and economic value than with respect to their botanical places. Specimens of all the timber growing in the district may be profitably collected and preserved; one side of the specimen being left in its natural state, the other planed, and dressed with oil.

Animals. — The study of animal life is also an important factor in the legitimate work of geography. In many instances the study may be made observational. The habits and characteristics of domestic animals will furnish a fund of useful information. It will be well also to discriminate between wild animals that are

useful and those that are hurtful to the husbandman. The study of the birds and insects with which the pupil is familiar will be one of great utility. If the pupils are encouraged to make a classified list of all the forms of animal life found in the district, the extent of the list will be a matter of surprise. When the list is discussed in detail, it will probably lead to the discovery that, in general, insects have the various forms of grub, chrysalis, and articulate stage.

Much may be done by reading stories about wild animals; in every case supplementing the story by pictures. The latter may be obtained in colors for a very small sum of money. Perhaps more can be done in the way of developmental work by skilful questioning than by observation and reading. The value of the list of questions given in Frye's 'Child and Nature,' pp. 112 and 113, will be manifest to every live teacher.

Minerals. — There are few districts which do not abound in mineral wealth. In the prairie states the list will be found to be surprisingly large, while in the rolling and mountainous regions the list may easily be extended beyond the limit of utility. The most important are, of course, the minerals of economic use. It will be well to have a collection of from fifty to one hundred of these, which should be labelled and mounted either on a block or a piece of stout card. It should comprise, among others, specimens of the different varieties of coal arranged in a series; several varieties of iron ore, notably hematite, limonite, magnetite, lodestone, and pyrites. Copper, zinc, nickel, lead, quicksilver, and tin ores may be obtained without much difficulty, and in every case the metal yielded by the ore should be exhibited. Native specimens of rock-salt, sulphur, gypsum, and the ochres may be obtained at a trifling expense. Equally important are the building stones, such as granite (syenite and gneiss), brown sandstone, white sandstone, marble, and other limestones, slate, clay, etc. It is best to have the pupils themselves collect or obtain the specimens. They should be labelled and mounted in as attractive a manner as possible.

The Atmosphere. — It is well to impress the fact that the atmosphere is just as much a part of the earth as the water or the solid rock. Do not allow the notion to be developed that all space is filled with air, and do not convey the idea that the earth 'floats in air.' Emphasize the fact that the air is the outer part of the earth, and moves with it in space.

That air has *weight* is always more or less difficult to demonstrate to a class, not because it may not be shown by simple experiments, but from the very common opinion that there is a force generally known as 'suction.' The boy's toy called the 'sucker,' a piece of thick, pliable leather, with a string fastened to the centre, is instructive as a means of illustration. When the sucker is saturated with water, and pushed firmly against a smooth board or a polished boulder, it requires considerable force to pull it away. The most convincing proof of the weight of air, however, may be found in the fact that a two-gallon glass jar, when exhausted by means of the air-pump, loses about half an ounce in weight.

It will be well, also, to develop the fact that the column of mercury in the barometer exactly balances or weighs a column of air of equal area. A serviceable barometer may be easily constructed by inverting a tube about thirty-six inches long, filled with quicksilver, so that the open end rests in a small vessel half full of the same metal. Measure the height of the quicksilver in the tube, and fasten upon it a paper scale of inches and tenths so as to mark the height of the column. The instrument thus constructed will show the changes in the pressure (weight) of the atmosphere with reasonable accuracy.

Show by any of the well-known experiments that air when heated expands in volume, therefore becoming, bulk for bulk, lighter than cold air. The boy's whirligig held over a hot stove at once acquires a rapid motion because of the ascending current of warm air. Do not allow the impression to obtain that hot air 'rises' because of its lightness. What really occurs is, that heavier cold air flows in and pushes it upwards.

The mutual but adverse motions of cold and warm currents of air may be best shown by the time-worn experiment of holding two lighted candles, one at the top, the other at the bottom of a door which opens into a heated room. In the study of the winds, it is not easy to find an illustration of wider application than this. It is an excellent plan to have pupils observe daily the motions of the winds, especially the direction of the wind which precedes storms and that with which the storm clears.

The *moisture* in the atmosphere may be shown in different ways. The 'drying up' of pools of water after a rain, the evaporation of water in an open vessel exposed to the air, and the disappearance of the dew after sunrise, may be made the subjects of extremely entertaining lessons. That moisture is present in the dry air of a room may be shown by filling a pitcher or other vessel with iced water. As the atmospheric moisture is condensed on the outside of the vessel, wipe the latter, and allow it to condense again, as a further proof. Lead, step by step, to the fact that when the temperature is lowered quickly, much of the vapor of water is changed to its ordinary liquid form, and appears as dew, mist, fog, cloud, or rain.

It will be an excellent plan to have pupils make daily observations on the winds, clouds, and general condition of the weather. Such observations may have but little worth in themselves, but they are direct means to a very valuable end. In many instances it will be practicable to have the daily weather indications displayed in the school-room, and in any case, good results will invariably come from keeping a daily weather-record.

Seasons. — Many instructive lessons may be drawn from the study of the astronomical side of geography. With primary pupils these will of necessity be fragmentary and incomplete. The pupil will, however, become familiar with many facts which will render the study of mathematical geography far easier in after years.

Have the pupils note the position of the sun at different times in the day, and explain to them the phenomena of its apparent motions. Note also the change in the position of the sun at ris-

ing or at setting during each month in the year. Measure the shadow of any fixed object at noon, during the successive months in the year. Some of these phenomena will be difficult of explanation to younger pupils, and it is perhaps better to attempt none — certainly none that will confuse. It will be practical, however, to connect the low noon sun and its northerly position at rising and setting, with the short days, long nights, and cold weather of winter. This, at least, can be understood by the most immature pupils.

The foregoing chapter, as is designated by its title, is intended to suggest a certain line of out-of-door work. Some of the ideas suggested are doubtless beyond the comprehension of very young pupils; others may be profitably repeated in a more systematic order when the pupil has reached advanced work in geography. The success of out-of-door work will depend mainly on the judgment of the teacher in selecting the material for the illustration of these object lessons. It will depend largely, also, upon the skill in interpreting natural phenomena, for any teacher who imagines that such work can be done without careful preparation will fail ignominiously in accomplishing tangible results. The teacher must not only acquaint himself with the study of physiography in general, but also with that of the district in detail in order to impart lessons that carry conviction.

During the period in which the out-of-door work is carried on, the more systematic in-door lessons should not be neglected. If a text-book is used, supplement and illustrate it with the moulding-board, with pictures, and with instructive stories from *authentic* books of travel.[1] If the mental pictures can be imprinted in the pupil's mind, almost any means will justify the end.

With the consideration of the foregoing topics, which may embrace a period of two years of time, there is a certain amount of

[1] Do not forget that there is much worthless literature under the name of books of travel. The books and sketches of inexperienced tourists who make flying trips through foreign places may be entertaining, but they are generally incorrect with regard to geographical information.

other observational work which also is included in geography; namely, the study of people, their social life, government, religion, etc. Much of this must be done with the aid of pictures and books of travel. Still another feature that will constantly come to the foreground is the geography of commerce. In spite of sentiment, the commercial idea is the one upon which all study and mental development centres. The opinion as to 'what ought to be' will not change the cold facts of the case, and the study of the commercial side will always be the practical objective point of geography. We may as well open our eyes to the fact that all human energy is bent to the purpose of procuring food and shelter. The net-work of railways, the fleets of steamers and sailing vessels, the coal and iron mines, the thousands of factories, the entire energy of the husbandman, have but one end in view — to allay hunger. All the mechanical energies of man are devoted indirectly to the production and transportation of food. Is it singular then that there are a few hard-headed, unsentimental people who will persist in putting the study of geography on a commercial basis? A journey through a grocery store will make a subject for many excellent object lessons, and a history of the travels of a battered coin will make a subject for many a written exercise. A well-known teacher in Boston requires one or more pupils to board nearly every ship arriving at that city from a foreign port, in order to learn the character of its cargo. It is safe to affirm that the pupils of that school know something about the geography of commerce that cannot be learned from text-books.

In teaching younger pupils, it will be an excellent plan to display commercial products in their various stages of manufacture. For instance, the cotton industry may be illustrated by cotton in the boll, in the raw or unginned state, in the spun fibre, and in various textile fabrics. A similar plan may be adopted with other textile goods, with the common ores which yield useful metals, and with articles of ordinary food. The various grades of sugar, tea, coffee, etc., are well worth the acquaintance of the pupil; and the usual processes through which grain passes in its journey from

the field to the table will be sources of instructive object lessons. If the teacher has any doubts about the value of the commercial importance of geography,[1] follow the commercial history of an illustrated school book from the time the raw materials employed in its manufacture are produced, until the finished volume is placed in the hands of the pupil. In the printer and binder's establishment alone, nearly one hundred distinct processes are necessary to produce an electrotyped book.

[1] 'In considering geography we deal with a subject particularly interesting because of its relations to man. It is the first of the elementary studies which teaches the child that he is part of a community, that the community is part of a nation, that the nation is part of the human race. He now learns how he differs from his European brothers in character, politics, society; and that these differences result from differences in the climate, the industries, and the geography of their respective countries. He begins to realize his dependence upon his fellow-beings. The coffee he drinks is prepared from beans gathered by savages in South America or in the East Indies. His tea is steeped from leaves dried by the Japanese or the Chinamen. Perhaps he sweetens his South Carolina rice with Cuban sugar. He eats mackerel caught in the fiords of Norway. Saginaw salt combines with India pepper to give relish to his Kentuckian sweet potato. Mediterranean sardines are served on slices of Californian lemons. His dime coined from silver mined in Nevada buys dates plucked from palms in Africa. Possibly he corks his ink bottle with a bit of bark from a tree growing in Spain. Thus every article of commerce testifies to the labor of his fellow-beings far and near. Distant countries are brought nearer by handling these commodities. But this dependence upon remote parts is due to climate; and climate depends upon altitude, latitude, forests, winds, rains, oceanic currents. These subjects are not treated upon in descriptive geography; hence to give satisfactory explanations, the teacher must understand physical geography, which in turn must be backed by natural philosophy. Indeed, a separation of descriptive and physical geography is impossible.' — MISS T. E. REUL, in *Wisconsin Journal of Education.*

III.

THE USE OF PICTURES AND MODELS.

The Value of Pictures. — No other view of a landscape is half so beautiful or so instructive as that which one obtains from a great elevation. No one can comprehend the profound depths of the Grand Cañon of the Colorado River who has not beheld this vast abyss from some overhanging buttress of Point Sublime. It is impossible to appreciate the immensity of the Rocky Mountains unless one views the ocean of peaks and folds from some point like Bellevue or Sierra Blanca. Only such outlooks as these afford that inspiration necessary to convey an idea of the vastness and the sublimity of nature's marvellous sculpturing.

And the reason is obvious. It is not merely a matter of height, nor of depth, nor of the gigantic proportions of any one object. It is the far-reaching panoramic view which enables one not only to behold the individual feature, but also to measure and contrast all features at the same instant, that so delights the mind. One naturally and instinctively seeks an elevated point from which to view an extended scope of country, and the teacher who habitually makes the Saturday excursion a part of the curriculum of school work, will testify to the value of a wide stretch of landscape as an inspiration and an incentive to the study of nature.

Who has not noticed the interest which is excited by a picture of a broad valley, flanked on either side by distant ranges of mountains? How flat and uninteresting in comparison is a picture of a single object of a landscape, stripped of every feature by which it can be compared or contrasted! The bird's-eye view is, and always will be, the chief assistant to the live teacher of geography and the delight of the pupil. It is worth a volume on improved methods

of teaching, and it will teach more in a given time than a dozen text-books. It furnishes an almost endless series of object lessons in physical geography, and it is more graphic than pages of descriptive matter. It teaches unconsciously; it appeals to the mind as well as the eye; it tells a plain story in a way that carries the profoundest conviction.

'If,' said a well-known teacher and author, 'I were to choose between two elementary text-books of geography, one of which was all text and no pictures, and another all pictures and no text, I should undoubtedly choose the latter, *if the pictures were true to nature*.' There are but few educators who will not agree to this, and the modern teacher finds her picture scrap-book fully as useful as the text-book, even with the more advanced classes.

The various illustrated papers and magazines, especially such journals as Frank Leslie's, the Scientific American, Harper's, Scribner's, and the Century always contain a host of illustrations which can be made useful to both teacher and pupil. It is well, moreover, to select and classify from fifty to seventy-five pictures which shall represent types of geographical forms, such as mountain ranges, peaks, valleys, plains, rivers, lakes, etc. In most of the text-books of geography the illustrations are excellent in character, and fairly true to nature.

The Moulding-Board. — In connection with the pictorial scrap-book, a very important auxiliary to the school furniture is the moulding-board. This piece of apparatus is practically a shallow box, four feet by three, and about two inches deep. It is most conveniently attached to a table about thirty inches in height in such a manner that it may be inclined at any angle. A zinc-lined box or drawer for holding the sand may be fastened to the under side of the table. Moulder's sand, such as is used in iron-foundries, is the best for the purpose, but any fine white sand will answer. It should be occasionally sifted, and should always be closely covered when not in use. Moulder's sand is always more or less cohesive; white sand should be occasionally dampened, but never made so wet that it is sticky.

The moulding-board is primarily for the use of the teacher. For the personal work of the pupil, Professor Frye some years ago introduced the use of a shallow modelling-pan made of tin, — a vessel about twenty by fourteen inches in area, with a rim an inch high. These are to be used by the pupils in repeating the forms of elevation and outline they have learned from nature, and in solving the various problems of slope and drainage which the teacher may deem essential.

It is well to bear in mind that the use of the moulding-board is intended for the repetition of forms which actually occur in nature, and not for the creation of forms which exist only in the imagination. The pupil should begin these exercises by reproducing those forms which are to be found about the school district. If these consist of rolling land, then he should proceed by easy steps to mould these features. If the pupil lives in a prairie region, the first lessons would naturally be the reproduction of a tolerably level surface with the ravines that score it. This should be followed by a representation of such forms as can be learned from pictures and description.[1] With the moulding of each form, the technical names which pertain to it should also be learned. Thus if a mountain range is under consideration, the terms, base, slope, cañon, summit, crest, peak, pass, etc., should be explained and the object moulded. It is better to work slowly and to insist on faithful representation. Recollect that neatness and consistency are just as valuable as disciplinary agents in child-culture, as are geography and arithmetic.

In representing coast-lines much pains must be taken to discriminate between the frayed rock-bound shores which characterize the coast of Maine, the cliff-skirted beaches like those of Newport, and the low, flat, sandy shores of New Jersey, almost

[1] Prof. N. S. Shaler of Harvard University has prepared a set of models which are of great value as *types* of earth-sculpture. These are accompanied by instructive photographs. A large number of photographs of typical studies in physical geography has been collected by the author. In every case these are reproductions from nature (see p. ooo).

rim-bound with islands and sand spits. These are types, and they should therefore be reproduced. In the same manner there should be some pains taken to show the difference between the young valley, with its sharp, angular outlines as typified in the Bad Lands, from the older valleys, with their rounded, symmetrical forms. The volcano, with its peculiar conical shape, its crater and monticules, will be found rather difficult of reproduction. It would be well, therefore, to use typical pictures of such forms, and guide their modelling by the accompanying description. In all cases avoid exaggeration of details. Do not give a mountain slope an angle of sixty or seventy degrees from the plain. It is rarely that the slope of a range exceeds twenty or thirty degrees — generally not more than twelve. Do not begin the forms of elevation by moulding a mountain peak. Isolated peaks are very rare, and when they occur they are of volcanic origin. Begin with the range and show how, by unequal wearing, some parts of the crest are left higher than others. These higher parts of the crest are the mountain peaks. Recollect that the range and not the mountain-peak is the unit. Proceed from the range to the series of ranges which go to make up the mountain-system. Mould the range as a fold or flexure, and not as a line of peaks; such an idea is unpardonable at this late day. The 'wind gaps' and water gaps or transverse valleys will also afford highly instructive lessons.

The more difficult subject of slopes and river-basins may follow when, in the judgment of the teacher, the pupils have sufficiently mature preparation. A good exercise may be found in the following plan. Take a sheet of thick writing-paper, and after crumpling it in the hand spread it out by pulling at the edges. The wrinkles in the paper will make a number of basins and divides which may be approximately copied in sand.

It is well to bear in mind that the crests of mountain systems and ranges rarely ever correspond with the divides between watersheds or slopes. The Rocky, the Sierra Nevada, the Appalachian, and the Andes Mountains are all pierced by streams whose sources are on one side, and whose mouths are on the other side of their

crests. The same is likewise true of many of the lofty ranges of Asia and Africa. To understand this will be somewhat difficult at first, but the difficulties may be avoided by constructing the slopes first and moulding the ranges in their proper places on the slope. This must not be regarded as a subterfuge to enable one to crawl out of a difficulty. Remember that it is in precisely the same manner that nature has solved the problem. Wherever a stream flows in a cañon through a mountain-range, the stream has always had the right of way, flowing in its channel long before the uplift of the mountain-mass began, and cutting its channel into the mountain-axis in much the same manner as the saw cuts the log which is moved against it.

It is an excellent plan to encourage the pupil to reproduce one or more models of the forms of land in clay. This will entail much extra work on both pupil and teacher, but the end will justify the means. In the clay model, accuracy to nature and faithfulness to the more minute details should be the first aim. When these have been accomplished the artistic effect is well worth looking after. The former is a testimonial to the energy and progress of the pupil; the latter is a source of delight not only to pupil and teacher, but to all who may see it. It goes without saying that such models should be carefully preserved in the school museum. There can be no more striking evidence of what the brains and hands of the average pupil can accomplish *when trained to work in harmony.*

As the pupils acquire greater facility in working with the moulding-board, and gain a more exact knowledge of the details of relief forms, the teacher should gradually require greater care in the specialization of types of relief, and greater accuracy of proportion. It will be a good plan at this stage of progress to attempt a relief map of the district. In many instances this task will be more difficult than it appears at first sight. It is not so easy to group a number of different forms, roughly moulded, as it is to reproduce a single one minutely. It will be well to construct an outline map of the district, indicating the positions of the various

features, and fixing a number of pins — say twenty or thirty — to mark their proportionate altitudes. The surface features may then be moulded to correspond with these. It is also a good plan to make a rough model in sand, at first, as a guide to the finished model in clay or plaster.

Throughout the whole course of work in moulding and modelling, faithfulness to nature is the one thing that both teacher and pupil should keep steadily in view. The whole object and end of modelling is *reproduction*, and not creation. The model is the expression of the form as it occurs in nature, and when the form has been so thoroughly photographed in the mind that it can be reproduced at will, then the model and the moulding-board may be put aside.

Clay Models. — The relief map is the outgrowth of the moulding-board and the model. It is designed to illustrate what cannot possibly be shown upon a flat surface. It naturally precedes the map, for the very same reason that we must study the physical geography of a region before we can obtain a comprehensive knowledge of its political and industrial features. But the relief map and the political map are complements of each other. Each displays features that cannot be well shown upon the other. The black outlines of a political map give no concept of a shore, and the hachure lines are equally useless in attempting to depict topography. On the other hand, a relief map is useless in showing political divisions, the grouping of population, or the routes of commerce, and, unless it is a highly finished and expensive map, it shows the drainage imperfectly at the best.

The quickly prepared relief, moulded in sand, should always be used by the teacher in illustrating the general topography and physiography of a region, country, or grand division; but this is quite a different thing from the finished relief map. The former should be moulded in sand, in the presence of the class. It should show only those general features of relief which separate distinct physical regions. Everything beyond this leads to confusion rather than to clearness. The finished model, on the con-

trary, should depict the topography as truthfully as our knowledge of the region will permit. It must be borne in mind, also, that the making of such a map is a work requiring much labor and time, and, if a finely finished, attractive model is desired, the modeller must possess not only good judgment and knowledge, but skill and artistic taste as well. To such of the more advanced pupils as show aptitude in this work, the discipline and skill acquired in the construction of a relief map will more than repay the expenditure of time and labor. The following directions will enable one to plan a relief map; the successful execution will depend on the skill, perseverance, and artistic taste of the modeller.

Let us suppose a clay model of the United States is to be constructed. Draw an outline map of the United States on very thick paper, of such dimensions that the width east and west shall be about three feet. Enter with pencil line the position and trend of all the principal highlands, mountain ranges, and divides. Procure from the United States Geological Survey a copy of Gannet's Dictionary of Altitudes (costs 20 cents), and pencil upon the map at equal or nearly equal distances the altitudes of the various localities. These bench marks may be about an inch and a half or two inches apart in the open plain regions, but are necessarily closer together in the highland regions. The map thus prepared is used as a memorandum for the relief work.

The base of the map should be made of 1½-inch boards matched closely and securely cleated on the under side to prevent warping. Lay the map on the surface of a large vessel of water, or else sponge the under side of the paper until the latter is thoroughly saturated, having previously cut away every part of the paper outside of the outline. When the paper is saturated, remove it from the water, place it face downwards on a large sheet of blotting-paper, and give it a coating of mucilage or bookbinder's paste. The surface of the board should be dampened, or, what is better, receive an application of paste on that part which will be covered by the map. Next, transfer the map to the board. Be careful that no air-bubbles are left between the

paper and the board, and use the utmost care that no part of the paper is pulled out of shape. After transferring, place the board face down on a sheet of paper and allow it to dry for a day or two.

The next part of the process is to fix guiding pins for the altitudes. On a relief map of the horizontal scale adopted, 20,000 feet to the inch will be found convenient for the vertical scale. Procure a paper of small pins, and set a pin vertically at each bench mark, the length of the pin above the surface being measured so as to represent the proportionate height of the surface. The clay, wet only enough to be cohesive, may then be worked upon the map, building it up to the level of the tops of the pins. Run narrow cylindrical rolls of clay along the mountain-ranges. Punch them into shape with the fingers first, and work the ridges into shape with a knife and a pointed piece of bone. Make the crests notched and irregular, and score the sides so as to break the irregularity of the slopes. The weather-worn summits of the highlands are difficult of reproduction, but the views of western scenery published by the various trans-continental railway companies will be of great service in suggesting the topographical features.

When the modelling is finally completed and the model is dry, there remains only the coloring and the finishing details of entering the water-courses, etc. If the color of the clay is not a pure white, it may be modified by carefully dusting finely ground plaster of Paris over the surface, any excess of material being blown off with a pair of small hand-bellows. The rivers may be most conveniently put in with a fine brush, using cobalt or ultamarine blue ground in oil. That part of the board which represents the sea-level should be sized, dusted with plaster of Paris, and, when dry, also colored blue.

Whenever contour maps can be procured, the work of modelling is made vastly easier. The contour lines being lines of equal elevation, it greatly reduces the work of establishing bench marks, and does away with the use of pins to mark altitudes. Sheets of pasteboard of uniform thickness are procured, each thickness

of the board representing a certain number of feet. If the contours are 200 feet apart, the thickness of the pasteboard will represent a relief of 200 feet. The contour lines are first traced on thin paper, and afterwards transferred to the pasteboard. The latter is cut along the line, and, beginning with the lowest altitude, the contours are fastened to the base-board. The successive elevations are built on this step by step, as the contour lines follow one another, until the work is finished. The clay may now be moulded over this form, and finished as before. This method was followed by Mr. Cosmos Mindeleff, who made a series of models for the author a few years since. It is by far the most satisfactory way whenever a contour map can be procured.

In every case the vertical scale should be exaggerated as little as possible. If the area to be modelled is a country or even a state, there need be no exaggeration whatever, or at the most it need not exceed 3 : 1. In the case of a grand division, the vertical scale may be raised as high as 10 : 1. Mr. Mindeleff's model of Europe, one of the finest works of the kind extant, has a scale of only 5 : 1. In a relief map of a large area some vertical exaggeration is absolutely necessary, but to raise the scale to 100 : 1 or 500 : 1, as is often done in profiles and cheap relief maps, is a gross abuse for which there is no excuse whatever. The relief map is intended as a reproduction, not a caricature of nature, and it is questionable whether one is justified in attempting to teach truth by the agency of a grave error.

IV.

THE RECITATION IN INTERMEDIATE AND ADVANCED WORK.

THAT the first steps in the study of geography should be entirely observational, and the instruction oral, are points upon which all educators agree. Beyond that point there are almost as many methods and opinions as there are teachers. Certain it is that most of the multitude of 'methods' are good if only they are faithfully followed. Whenever the method is designed to develop and strengthen the thinking powers of the mind — whenever its use begets increase of perception and the logical deduction of cause and effect, — then it is good. If, on the contrary, the method is designed to enable teacher and pupil to acquire the greatest number of facts in the shortest space of time, with a view to passing an examination for promotion, — even then the method has something of good in it. It is good for the teacher, if the class reaches the necessary per cent promotion; it is good for nothing as a means of education. In the following pages no method is laid out to be followed. The suggestions which are offered are adaptable to any method which educates; the cautions are mainly those which will enable the teacher to avoid a waste of energy. Neither the suggestions nor the cautions will be available if the teacher's work consists only in making the abutments for an examination bridge.

The recitation should be a teaching, and not a lesson-hearing exercise. The quiz exercise, by which the teacher tests the faithfulness of the pupil's memory work, is proper at times; it has its legitimate place in the recitation. But when the recitation is made exclusively a question-and-answer fusilade of text-book matter, then the true work of the teacher ceases, and the latter

becomes a sort of record-book clerk. Too often the quiz-work is made the primary, and true teaching the secondary, work of the recitation.

Should text-books be used in intermediate and advanced geography study? If the pupil can understandingly read the text, yes; if not, no. It is a waste of time for the pupil to attempt to read a book until he has learned to read; up to that time the work must be oral. Oral work of excellent quality can be, and has been done, in intermediate grades, but there is much loss of time and energy. Good sewing can be done by hand, and good watches can also be made by hand, but in both instances the work becomes very expensive, because the use of the tool or machine enables the workman to accomplish much more in a given time than the unaided hand can do. Now the book properly used is a tool which enables both teacher and pupil to do better work in less time.

The objection is often raised that the pupils will learn and recite the words of the book without comprehending their meaning. Certainly they may, but not until they have been driven to it by unskilful teaching. The legitimate work of the recitation will prevent this. At first the pupil uses the text-book as awkwardly as he would use any other tool, but, under the skilful questions of the teacher, ideas begin to grow out of what were at first meaningless words. This is an educating, — a true teaching process. At first the recitation must be mainly devoted to teaching the pupil how to study the lesson, for it cannot be expected that he will do so without assistance. This is not an easy matter, and the ability to do it well is a crucial test of good teaching. Little by little, as this is accomplished, the teacher's help may be withdrawn. Work of this kind is wholly developmental, and while it is going on, it is essential to have the books wide open in the hands of the pupils. In other words, they must study, learn, and recite at the same time.

It is necessary that the style of the elementary geography should be simple, clear, and inductive — easy words, short sen-

tences, and well-arranged paragraphs. Fortunately many of the elementary geographies have this merit. In a few instances, however, the text merely outlines a course of the first steps in geography. A book of this character, however valuable as a teacher's manual, has no proper place in the hands of pupils. The oral lessons, which properly constitute the beginning steps of the pupil in the study of geography, necessarily come at a time when he is unable to read understandingly. When the pupil can read with some fluency, when he can comprehend the meaning of what he ordinarily reads, then he has reached the stage of development where the book may be properly used. The child learns to read so that he may study books. If he is never to study from a book, why learn to read at all? The wise teacher — if the school-book syndicate permits — will choose an elementary text-book in which geographical knowledge is presented in a style which can best be digested by her pupils. She will have a wide choice between the book of fairy stories without geography, and one which is all geography without the stories.

In the advanced work in geography, — that is, when the pupil takes up a 'grammar-school' or 'complete' geography, — the work of both teacher and pupil is necessarily different. There is more memorizing, and less developmental work to be done. The former must be done by the pupil during study-hours; the latter, under the guidance of the teacher. The topical recitation, the pupil once properly trained to it, will furnish the test of his faithfulness during the study-hour. Not only this, but it also trains the pupil to express his thoughts fluently, concisely, and correctly in his own language. If nothing else were accomplished, this alone would be a valuable discipline. But the true work of the teacher begins at this point; namely, to round off the facts recited, by developing their logical connection, their sequence, and the operation of the causes which produce effects. This can be done only by skilful questioning — questioning of a similar kind to that by which the expert lawyer ferrets out the innermost secrets of a

recalcitrant witness. It goes without saying that the questions available for such work are not the ones found on the printed page of the text-book; on the contrary, the questions not found there are those which will best arouse the mental activities.

In advanced, as in elementary work, the reviews should be frequent and searching, The skilful teacher will make quick and thorough work of the review, and, while taking new steps, will emphasize their dependence upon those mastered.

The advanced text-book in geography may of necessity contain much more material than is desirable for any one pupil to learn. This feature, when we examine it rightly, is essential to any useful text-book. Difference in the locality of the school, in the grade of the class, and in the specific work of the school, necessitates a different selection of the material to be taught. The text-book must, therefore, contain more matter than is needed by any individual or class; the map must contain many names and localities not alluded to in the text, and there must be more or less memory work. The 'cyclopedic' geographies undoubtedly have their disadvantages; but on the whole, redundancy of material is hardly so serious a fault as paucity of ideas.

Do not attempt to teach the physical features of a grand division, or other large body of land, from the ordinary colored map. Use a relief map if you can get nothing better, but by all means endeavor to use a sand or clay model. These can be made sufficiently accurate to show the main divides and slopes. Show none but the great characteristic features at first, then, if there be opportunity and time, develop the incidental features. For instance, suppose we were to mould the United States. After laying off the general shape of the country, mould a single ridge to represent the Appalachian Highlands; another to represent the Rocky Mountains proper; and another to represent the Sierra Nevada and Cascade chain. Press the sand or clay into the proper shape on either side of the Mississippi River to show the foot-hills of the Appalachian Highlands on one side, and the elevated 'plains' on the other. Show the general structure of the

Great Basin between the Rocky and the Sierra Nevada-Cascade chain. Make a very gentle swell to separate the Arctic from the Gulf and the St. Lawrence drainage, taking care not to mould high ridges here, for there are none. This swell represents the Heights of Land. Such a model will show all the characteristic physical features of the country, and these should be thoroughly understood by the pupil before studying the subordinate details.

Do not teach natural products as confined to political divisions: they belong to physical, and not political, regions. Thus, in North America we have the cotton and sugar belt, the grain belt, and the timber belt. These are interrupted more or less by intervening high lands or low lands, but they lie mainly between isothermal lines, and this fact should be impressed. When the pupils study other grand divisions, it will then be seen that the zones of vegetation and of animal life may be traced fairly around the world. In the same manner we may lay off mineral productions — not by zones or by political divisions, but by areas. A brief lesson will show that the distribution of these follow somewhat definite laws. In short, the physical geography of the political division should not be studied until the student has some knowledge of the general geography of the whole region: then the special features of the state, county, or district in question may be studied.

Do not require pupils to describe the meanderings of a river. It is enough to give its general direction, or at most, the direction of the upper and the lower courses. It is sufficient to say that the Missouri flows southeast — it is much better to let the pupils discover that *all* the streams of the region west of the Mississippi have a general southeasterly direction. The former is an incidental fact; the latter calls the attention to a general law. It is quite proper to study river-meanderings in connection with erosion, corrasion, and plain-building; but even in this connection it is the law which underlies the whole, and not the single individual case which teaches the lesson.

Do not require pupils to memorize definitions except in rare instances. Generally speaking, the live teacher will require her

pupils to make their own definitions. With moulding-board and sand or clay, show the thing itself, and then by cross-questioning develop the definition. The child's definition may not be so concise as that in the text-book, but he will have the correct idea; and a correct idea in faulty language is much better than a grammatically stated definition with no idea at all. A skilful teacher may succeed in conducting a recitation in geography and have every answer grammatically and rhetorically without flaw. The only objection is that no geography is taught.

The question arises, 'Should there be definitions in the text-book?' Most certainly there should, but they should be sparingly employed in the primary book. Knowledge of the thing necessarily precedes the definition. The moulding-board and the picture are only crutches or supports. Now, until the child has learned to walk alone, something in the shape of a crutch or support is needful. The picture and the moulded form are crutches which the younger pupil must use until he has *learned to think in words.* When he has done this, the artificial supports may be discarded, for it does not follow that he should use them all through life because he needs them while learning to walk.

The definition belongs properly to the higher or secondary book. When the pupil reaches this stage, he is supposed to be able to think in words. By this time, if the primary work has been properly done, he *knows the definition at sight,* — perhaps in different words from those he sees before him, — and the printed definitions of the book are only a series of texts from which many points may be drawn.

Do not require pupils to study all the map questions on the printed page. You cannot answer them yourself without referring to the book; and if ever you have been able to do so, it was the work of only a few weeks to forget them. Select only those questions the answers to which underlie principles. What is still more important, arrange the order of the questions so as to develop ideas beyond the mere answers. For instance, on a certain page

are the questions, 'Where is the Mississippi River? the St. Lawrence? the Mackenzie? What ranges of mountains in the eastern part of North America? the western? Where is the Great Central Plain?' Now let us change the order and reading of these questions slightly, and see the difference in their import. 'What highlands form the western border of North America? the eastern? What is the character of the lands between these highlands — are they level or mountainous? Note the direction of the Mississippi River and its branches — the Mackenzie River. What does this show about the slope of the land? Draw a line which shall separate the head waters of the rivers flowing into the Gulf of Mexico from those flowing into the Arctic Ocean and Hudson Bay. Is this line a straight east-and-west line? Can you tell whether it is the ridge of a mountain range, or the crest of a swell of land? It is called the Heights of Land. Why is it so called?' Notice that questions of the first set are more or less disconnected, and mean nothing unless considerably enlarged upon. The arrangement of the latter series develops the general structural features of North America. The map questions in the best text-books are designed, not to represent the proper number or most logical sequence of questions, but rather as a reservoir to be drawn from at the discretion of the teacher. Inasmuch as every teacher has his individual methods, which are more or less modified by circumstances and locality, it is better to make a selection of questions rather than to require pupils to learn the answers to a host of irrelevant ones.

Furthermore, there are many questions not found in the text which will suggest themselves. They are mainly questions which depend more on the pupil's understanding of the subject than on the fact that he has faithfully studied the day's lesson. Almost every text-book question should be flanked by one or more test questions which dig deep into the child's knowledge. Besides such test questions there are always questions of another kind which are very useful in gauging the pupil's perception. These, of course, are oral, and should be sprung upon him unawares. For

instance, 'Is the greater part of Africa north or south of the equator?' 'Which is farthest west, New York or Valparaiso?' 'Which is the farther north, New Orleans or Naples?' These are questions which are very good tests of the pupil's power of perception, and their utility lies in their not having been studied beforehand. It goes without saying, that when such questions are employed in the manner indicated, the pupil should not be held responsible for an incorrect answer.

There are many occasions when the best work of the teacher can be done with the map in hand. By timely-put questions, the teacher will lead the pupils to discover many important facts which are not only interesting, but valuable. The individual answers to the questions may not always be remembered, but the principles deduced will not be forgotten. Aside from this an occasional question will often disclose the fact that the teacher has not thoroughly done his work. For instance, with the map of the United States open before the class, get an expression of opinion as to which is the farther west, Cape Mendocino or Cape Flattery. An answer to this question will enable the teacher to learn whether the pupils have the common habit of measuring longitude from a meridian or from the margin of the map. Questions of this character will always suggest themselves, and the faithful teacher will not hesitate to use them, just as the faithful artisan in every profession proves his work as he goes along.

Do not require every little creek that flows through or near a town to be associated with its name. Before the advent of the railway there was good reason for associating a city or town with the name of any navigable stream which was its commercial outlet; but what earthly use is there in connecting the name of a town with an insignificant creek that could not float a row-boat? Even now we rarely ever think of Kansas City as situated on the Missouri River, or Sacramento on the Sacramento River. The reason is apparent. Both of these cities are important railway centres, neither one having any river commerce of importance. On the contrary, it is worth while to associate Cincinnati and New Orleans

with the respective rivers on which they are situated, for these are pre-eminently river ports. It will not be improper to associate Chicago with both foreign and domestic commerce, inasmuch as, in addition to its being the largest railway centre in the world, it is also the first lake port in the Western Continent. More vessels clear from its harbor than from the harbors of New York, Philadelphia, and Baltimore combined.

Do not make imaginary journeys over impossible routes. There might be a case where it were necessary to ship a consignment of woollen blankets from Pittsburgh to Jerusalem, but it is not likely to occur before the millennium. There are many beaten highways of travel which are well worth following in imagination, and there can be no objection to following these; indeed, if the teacher will fortify himself with the statistics of commerce, obtained directly from the office of some extensive shipping merchant, the lesson will not only be a practical, but also a valuable one.

The commercial aspect of geography is a strong one, and teachers who will take the trouble to apply to the Department of the Interior for the Consular Reports will find in them a mine of interesting and useful knowledge. Railway folders and guide-books always contain useful information; and inasmuch as they are issued yearly, fresh and fairly accurate information may be found in them. The foreign guide-books, such as Baedecker's and Hare's 'Walks' are invaluable to the teacher of geography. They contain interesting descriptive, historical, and statistical matter that cannot readily be found elsewhere. A set of either of these books will be found fully as useful to the teacher as a cyclopedia or a geographical gazetteer.

It is not a good plan to require pupils to memorize the localities of unimportant places. There are probably not more than one hundred cities and towns in the world whose situations need be memorized, and of this number there are not many which require to be specially located. In general, the memory should not be burdened with the position of any geographical feature unless there be some point of history, strategic position, or com-

mercial industry connected with it; that is, the place and the thing for which it is noted should always go together. Not long since a contributor to an educational journal strongly advised that the latitude and longitude of every important place be learned, and made a part of its descriptive location. It is almost incredible that such a useless and cruel task should be recommended at this late day, but it is hardly probable that any teacher would be unwise enough to carry out such a suggestion.

Exercises in 'bounding' a country or state are sometimes available in fixing the location of a political division, but to extend the practice to every petty division is wholly unnecessary. The pupil should know what counties and states surround the one in which he lives, but it is very easy to carry an exercise of this kind too far. Do not force every boundary to be either north, south, east, or west. If we consider the irregular shapes of such divisions as West Virginia, South Carolina, Italy, or Brazil, it is manifestly better to give southeastern, southwestern, or any convenient composite direction of boundary. Oftener it will require less time to mention the surrounding political and natural divisions without any reference to their direction. A navigable river or a high mountain range will not infrequently be more important to dwell upon as a boundary than a political division.

V.

MAP-DRAWING AND MAP-MAKING.

WHENEVER we wish to learn the position of a place of which we know but little, the first impulse is always to consult the map. This we do, because in long years of time we have learned the true use of the map. The map not only tells us the position of the particular locality on the earth's surface, but also its position with relation to other places. In early life we seek the picture of the thing if we cannot have access to the thing itself; in many instances the picture is often more graphic than the thing — because it enables the mind to view a wider horizon. Thus, even in mature years, one can get a better idea of a city or a large area of country by consulting a 'bird's-eye view' than by travelling over the extent of country, or by wandering through the streets of the city.

Now, in the study of geography it is necessary to construct views which shall enable the eye to take in as much as half, or even the whole, of the earth's surface at once. This representation is the map. The map, of necessity, is not a picture. We cannot delineate as pictures any except very small areas, and have them true to nature. So we are forced to represent nature by the use of very arbitrary lines from which we are supposed to reproduce the object itself in the mind's eye. In other words, we make what we call a map to reproduce a mental image of the thing itself.

The most vigorous imagination, however, cannot see any resemblance between a round dot and a cluster of houses, or between the hachure lines of the map and a range of mountains. There may be a slight resemblance in the sinuous black line which serves to recall the actual river, but there is nothing in the shore-line of the maps to recall the low sandy beach or the wave-beaten cliffs

that frown upon the sea. There is even less in the gaudily painted colors of the map to suggest the beautiful landscapes of nature. But the map, notwithstanding its innate ugliness and conventionalities, has a practical side to it which makes it intrinsically more valuable than all the picture-lessons we can possibly derive from nature, for without it foreign commerce would be almost an impossibility, and domestic commerce would be greatly crippled.

It goes without saying, that before the child sees or studies the map he should become acquainted with the things which the conventional lines on the map represent. The various forms and elevations of the earth's surface, such as mountains, islands, capes, bays, peninsulas, straits, etc., should be studied first from nature. Where this is not possible the moulding-board and the picture furnish the next best means. Simultaneously with these, the conventional outline may be drawn on the slate or on the blackboard, and thus the pupil takes his first lessons in map-drawing.

In the class-room, perhaps the most practical map-drawing is the hasty off-hand sketching of an area which the needs of the recitation demand. In such sketch-map only a general accuracy of outline is required, and not more than two or three minutes should be permitted in making it. If the pupil has been habitually trained to such work in the oral lessons on the moulding-board, there will be no difficulty in doing it quickly and with reasonable accuracy. The ability to make a rough sketch-map of a given area consistently and rapidly implies a great deal. It shows not only that the pupil has the outline photographed in his mind, but it is also proof positive of a kind of knowledge that is not readily forgotten. Beyond the disciplinary value of such work the outline itself is more valuable in its way than the wall- or the atlas-map. A few lines drawn in their proper places will show the continental divides which separate the great slopes and basins. On such a map these can be seen more clearly than on the atlas-map because there is no confusion of details to distract the attention from the particular features. There is a score of similar uses to which such a sketch-map may be put, any one of which will

enable both teacher and pupil to do graphically and vividly what must otherwise be imperfectly done. One who has tried this expedient will not fail to acknowledge how much time and explanatory talk may be thereby saved.

The production of finished and artistically drawn maps is an art — and a science as well — which the majority of teachers look on with disfavor. It certainly is not an essential element in the education of the average pupil, and if such work is done, it would be better if done mainly out of school hours. But whatever may be the value of a knowledge of chartography to the pupil, it is a necessity to the teacher. The clumsy, unskilful devices commonly recommended as 'aids to map-drawing,' although they often reflect credit upon the ingenuity of the teacher, are not testimonials to his training in the study of geography.

Most likely the majority of teachers use a conventional system of construction-lines upon which the outlines of the land-area are to be drawn. This system sometimes, though rarely, serves a good purpose, and where a map is to be hastily sketched it is occasionally convenient. As a supplement to a correct system of map-drawing it subserves a good purpose. But if the pupil's knowledge of the *science* of map-drawing is to stop at this point, it would be better that the knowledge were never acquired; it is always misleading, and usually erroneous. The object and essence of the map is that every geographical point should be in its proper place. With the ordinary construction-diagram no attempt whatever is made to show anything but an outline similar to the map copied. Neither is there anything to show the latitude and longitude of places, or even the general position of the area charted. For a map of a township, or even a county, such an outline might be useful; but for a large area, it is unscientific, incomplete, and erroneous.

Now and then some one discovers that a construction-diagram which answers admirably for, we will say, a map of North America as it appears in one book, will not answer at all for the same map as it is given in another. When such an awkward discovery is

made, one of the maps (usually the one to which the construction-diagram will not fit) is declared incorrect.

That construction-lines and diagrams are a necessity in map-drawing is certainly true, but why not use the ones originally designed for the purpose, and without which a map is useless? In other words, why not use the parallels and meridians themselves? They were devised for this purpose and, except in mariners' charts, have little or no other use. The professional map-draughtsman uses them and does not ever think of using any other device.

The advantage of using parallels and meridians is twofold. It is fully as easy to lay them off on paper as it is to draw a meaningless construction-diagram. The map when thus drawn is consistent, and expresses not only position, but also direction and relative distance. Without the parallels and meridians, it shows nothing but outline; and if the outline were one of a country or a region not well known, it might be difficult to decide how the map was to be read, or in which direction were the cardinal points.

The chief difficulty is that both teacher and pupil are afraid to attempt drawing the parallels and meridians, for fear that they will not have the same appearance as those of the map copied. This fear may be dismissed with the assertion that they need not be similar. They may be drawn as straight lines if one chooses to draw them thus, and if they are properly numbered the map may be charted upon them. The result will be a *consistent* map, although in shape it may not absolutely resemble the one copied.

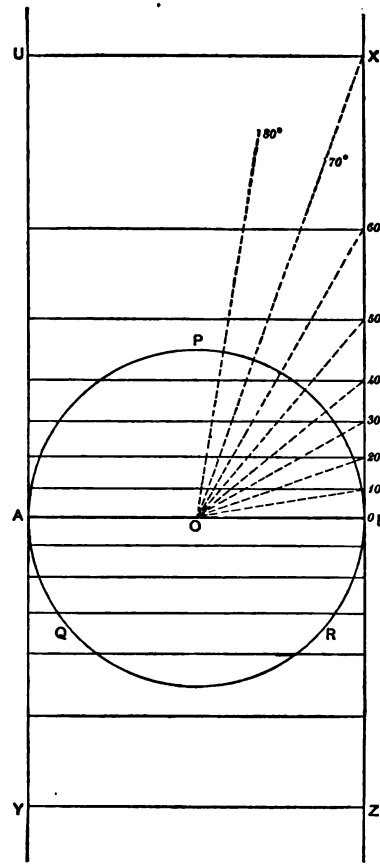
Pupils and teachers have been taught, or have imbibed the idea, that a map must of necessity be an exact outline of the continent, grand division, or state. This is a matter which must be unlearned. A map cannot, of necessity, be an exact outline, because it is impossible to represent the outline of a convex or rounded surface on a flat surface. The map-draughtsman must therefore be content with making the map as nearly correct as circumstances will permit, and must lay out his parallels and meridians accordingly. The platting of these is called 'projecting the map.' There are

many projections used in map-drawing, but there are four which are very commonly used,—the Mercator, the conic, the polyconic, and the globular projection.

The Mercator Projection. — This projection receives its name from Kaufmann,[1] a geographer who first employed it in the charting of sailing-routes.

In the Mercator projection the earth is considered a cylinder, on the convex surface of which the outlines of the continents are drawn. If, now, we conceive the surface to be unrolled and laid flat, the result is a map projected on the Mercator plan.

But the north pole of the earth, which in reality is a point, becomes, in the Mercator projection, a circle equal in size to the circle of the equator. The land masses situated in high latitudes appear greatly distorted, therefore, in width. In order to obviate this, the distance between parallels constantly increases as the latitude increases, as will be seen in the accompanying diagram. These distances are not taken hap-hazard, to suit convenience, but are determined



Method by which Mercator Charts are projected.

[1] Kaufmann is the German word for *merchant*, which in Latin is *mercator*.

for a purpose, and their positions calculated with mathematical precision.

Technically speaking, the distance of each parallel from the equator is equal to the tangent of the angle of latitude. Let us imagine that UXYZ is a hollow cylinder of paper surrounding a terrestrial globe PQR. From O, the centre of the globe, lay off angles of 10°, 20°, 30°, etc., and draw lines until they meet the side of the paper cylinder. Now the points where these lines meet the surface of the cylinder will be the distances of the respective parallels from the equator. When we unroll the paper cylinder, it will be about $3\frac{1}{7}$ times the length of AB, the diameter of the globe. For all practical purposes the maps projected on the Mercator plan are limited to 80° N. and 60° S. latitude, as the land and all the navigable waters of the earth are situated between these parallels.

The chief objection to this plan of projecting a map is, that where large areas are to be shown, the size of those portions situated in high latitudes is greatly exaggerated. This objection, however, fails when small areas are to be charted, and for state and county maps it is an excellent projection. It is the only convenient projection, too, in which the entire surface of the earth can be shown on a single, continuous map.

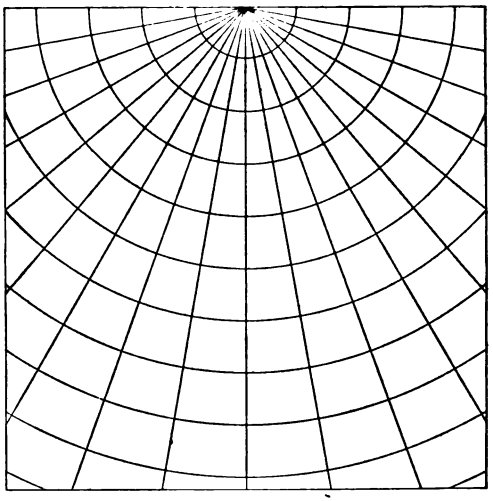
Its greatest advantage lies in its use as a sailing-chart; for it is in maps of this projection only that all directions are measured in straight lines, and that parallel lines have the same direction in all parts of the map. Without the Mercator chart, deep-sea sailing would be out of the question, for any navigator who was not a good mathematician could not calculate the complex curves which on ordinary maps would represent straight lines on the surface of the earth. The 'commercial' maps of the world, which now form a part of most common-school geographies, are excellent specimens of the Mercator projection, although not always correctly projected.

It need not be inferred from this that the chartographer does not know how to project them. The reason is, that a correctly

projected map, to include all the surface between 80° N. to 80° S., if a two-page map is required, would be about three feet in length from top to bottom. So it is customary to reduce the distance between parallels by any convenient but arbitrary scale, the latter depending upon the size of the page.

The Conic Projection. — The conic projection represents a part of the earth as drawn on the surface of a cone. Imagine a cone (or a part of the cone) covered with paper, on which the parallels are drawn parallel to the base of the cone, and the meridians from the apex to the base. If now the paper be removed and spread flat, we shall have a tolerably correct idea of the conic projection. This form of projection and the various modifications of it are much used in charting those grand divisions and areas which lie in the northern hemisphere. Obviously, the distortion will be the greatest towards polar and equatorial latitudes. If we bend the paper into a cone, and place the latter over a globe which shall just go inside of it, we can see what parts of the map are distorted or incorrect in outline. Along the circle where the sphere and cone touch, there will be no distortion. In polar latitudes there will be a north and south exaggeration, and in equatorial latitudes, an east and west enlargement. Where the area to be charted extends well into equatorial latitudes, the meridians instead of being straight lines are commonly curved inwardly so as to prevent too much lateral distortion. Maps of Asia and Europe are usually thus conventionalized. In fact, two of the best chartographers in the United States use ship-curves for projecting the meridians in the maps of these grand divisions. In using the ship-curve instead of the arc of a circle, their judgment is good. In a projection thus made, the northern regions, where there are but few details to be charted, are slightly contracted, while the southern parts, in which the details are numerous, are slightly enlarged. The parallels of a conic projection are always concentric arcs with the pole as a centre. The conic projection is one of the most convenient, and in many respects the best, for pupils' work. It is easily made, and requires no apparatus more costly

than a pair of dividers with a long leg. The meridians may be straight lines, and the parallels, arcs drawn from the apex of the



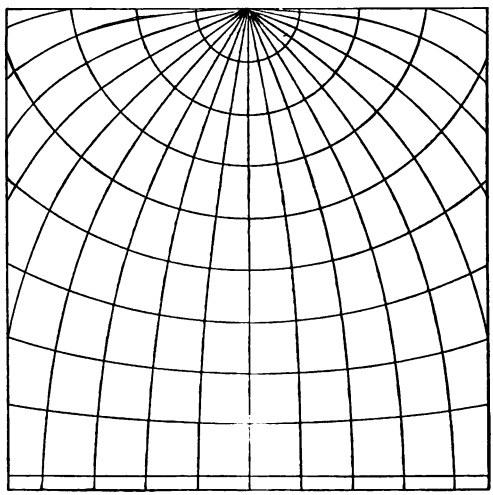
A Conic Projection.

cone as a centre. The outline on p. 47 conveys a practical idea of this form of projection.

The Polyconic Projection. — The polyconic projection is the one adopted by the United States Coast Survey. It is, generally speaking, more accurate than any other, inasmuch as it gives a rather more correct outline to the surface charted. In this projection the parallels are arcs of circles drawn from centres which recede from the north pole as the latitude decreases. The meridians are arcs of circles. This is a difficult projection to make, and should not be attempted by the pupil. It is a favorite projection for the map of North America.

The Globular Projection. — The maps of the hemispheres which are found at the beginning of most geographies are drawn

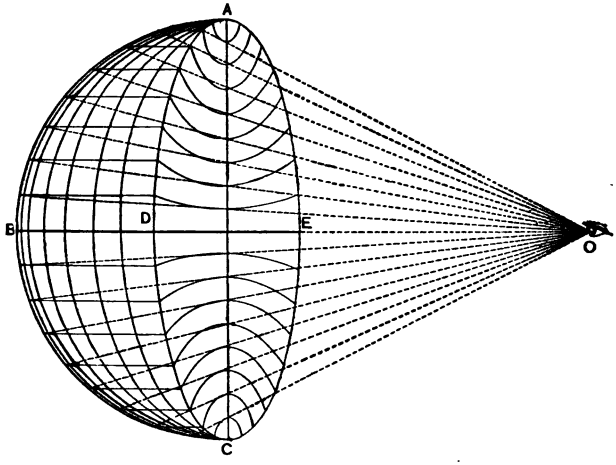
on what is commonly called the globular projection. It was first planned by de la Hire about two hundred years ago, and a better



A Polyconic Projection.

one for the purpose was never made. Let us imagine a glass globe on which the parallels and meridians have been drawn, to be cut in two through the poles, and a sheet of half-transparent paper fastened over the cut edges. In the accompanying cut ABCDE is the hemisphere, and ADCE the sheet of paper. The observer stands directly in front of the flat side at a distance a little greater than the length of the axis of the sphere, the eye being at O, on the level of the equator. Now as one looks at the parallels[1] with the eye in the position shown at O, they seem to be curved lines; and if we could have each one drawn as it seems to fall on the flat surface ADCE, we should have a set of parallels as seen in the next figure. The meridians are usually drawn at equal distances apart. The expert chartographer does not need

[1] The meridians are omitted in order to avoid crowding the figure with a confusion of lines.



Method by which Globular Maps are projected.

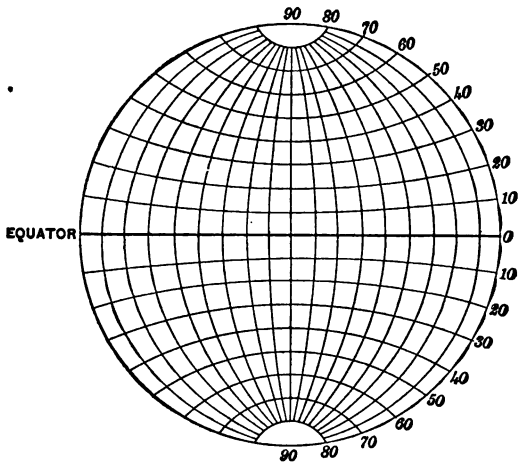
to take this trouble to locate the position or to find the curvature of the parallels; he can calculate either much more easily.

In a projection of this kind, the distortion is chiefly at the margin of the map. On a globe the parallels must of course be equidistant, but in our globular projection they are much farther apart at the margins than along the central meridian. Not unfrequently the question arises, 'Why is there not a scale of miles on maps of the hemispheres?' Such a question is readily answered when we recognize the fact of this marginal exaggeration. A scale of miles which would be accurate on the central meridian would be very inaccurate at the margin. To represent a fairly correct scale each unit must be 1.57 as great for the marginal as for the central meridian.

It is evident that directions north and south, or east and west, are measured respectively along the meridians and parallels, no matter what may be the direction of these lines on the map. A straight line on the map must, therefore, in nearly every case be a curved line on the globe; it becomes not only a great inconvenience, but practically an impossibility for any but an expert mathematician to use such maps for sailing-charts. But

inasmuch as a map projected for use as a sailing-chart has such exaggerated outlines as to be almost worthless for everything except rhumb lines and accuracy of direction, we must gracefully submit to the fact that two kinds of maps are necessary, — one for landsmen, and the other for seamen. We must also yield to the fact that while both are consistent, neither one is accurate, and that a perfect map cannot be made until we have a flat earth.

One of the difficulties in trying to fit a round earth to a flat map is frequently encountered in the United States Land Office.



The Completed Projection.

According to law a township must be bounded east and west by meridians, and must be six miles *square*. Now this is simply an impossibility. If, for instance, we survey two township lines northward from the 40th to the 41st parallel, we shall find that they have approached each other and are about two-thirds of a mile nearer at their northern than at their southern limits. In the system of land surveys adopted by the United States, standard parallels are surveyed every few miles apart, and these are taken as

bases for new township surveys. The parallel taken for a new base is called a 'correction line.'

Occasionally the cry is raised that the maps of our geographies are objectionable because they contain too many details. Certainly the map should not contain so much matter as to be confusing, and all unnecessary lines and schemes are a source of evil rather than good. It is true that not every indentation of coast can be accurately shown, but it is equally certain that the character of the coast may be delineated; and if the map shows no difference between the coast-charting of Maine and Florida, it is not a true map. Mountains can be shown only in a conventional way, yet the character of highlands and cañons can be distinctively portrayed. If the hachure lines representing a mountain range, a plateau, a line of cliffs, and a cañon show no difference in texture, the map is untrue. It is a mechanical impossibility to enter the names of cities and towns on a map of a section of states, systematically, and in ratio to the population. The chartographer can only submit to what he cannot help, and use his best judgment. Now and then some one blindly proposes to introduce the names of a few of the larger cities only on each section map. Such a scheme is not only unnecessary, but misleading. It is unnecessary because in all the standard text-books of geography the greater centres of population are designated by larger type or by special symbols. It is misleading because it is untruthful. There is no more instructive lesson to be derived from the ordinary map than that shown by the distribution of population over an area of country, and the wise teacher will not fail to recognize this feature. Aside from this, the text-book map has a very important use as a reference map, and if all but the salient features are removed, the map has no value whatever beyond its class-room use.

Where maps containing only essential features are required they would best be drawn by the pupils themselves. For this purpose it is a good plan to take advantage of outline maps — that is, maps which have already been projected. The details, whether physical, political, or historical may then be filled in progressively, using a

different sheet for each purpose. The plan of thus 'editing' a map will be found an invaluable discipline to the pupil. Indeed, it is doubtful if a better plan to judge graphically of the pupil's progress could be devised.

Fortunately the maps of all the leading geographies are excellent ones. In nearly every instance they have been prepared either by Mr. Jacob Wells, of New York, or Mr. W. H. Holmes, of Philadelphia. Both of these gentlemen are widely known as geographers and chartographers. They have no superiors in their professional work, and whatever may be the short-comings of the maps of text-books, the fault rests with the employers and not the chartographer.

VI.

HINTS ON TEACHING MATHEMATICAL GEOGRAPHY.

WHILE mathematical geography is out of the question with primary classes, pupils of grammar and high school grades should be well grounded in those principles of mathematical and astronomical geography which are essential to the study of physiography. Text-books on physical geography are sometimes unjustly criticised because they contain prefatory chapters on astronomy. If every pupil could receive a course of instruction in astronomy before beginning the study of physical geography, such a criticism would be well taken. But in the great majority of schools, the only information the pupil ever obtains on this subject is drawn from school text-books of geography, and, in view of this fact, the introduction of the few elementary principles of astronomy is not only pertinent, but essential.[1]

About the only essential apparatus needed in the study of mathematical geography is a good terrestrial globe. It is better to have an eight- or a twelve-inch globe mounted in a frame so as to show the plane of the ecliptic, but if this cannot be procured, a cheap globe mounted on a wire — one can be purchased for twenty-five cents — can be made to answer every purpose. A pair of compasses or dividers, with pencil and pen points will also be useful. One or two croquet balls painted white (with a color mixed with turpentine or benzine) will make a good surface on which to draw the various circles and project the outlines of the divisions of land and water. Not all the exercises suggested need be carried out by each member of the class. Many of them

[1] This is also true of elementary geology. A knowledge of the elements of these two studies is absolutely necessary to an understanding of physical geography.

may be made general exercises. Pupils fitting themselves for teachers, and teachers of ungraded schools, where but little apparatus is ever found, will do well to carry out the suggestions for extemporizing suitable apparatus. In very many instances home-made apparatus is better than that which is purchased. It is less complicated, and because less complicated, the essential principles are presented in a simpler and bolder manner. Besides, a teacher who can contrive his own apparatus has a comprehensive knowledge, a *grip* on the subject in hand, that can be acquired in no other manner. The discipline is just as advantageous in other studies as in geography. It is impossible to discipline the mind or cultivate skill in one direction without a corresponding development in others.

It will be unnecessary, perhaps, to use all the exercises given. The real ability of the teacher becomes manifest in judgment of selection; superfluous proof does not strengthen conviction, and over-illustration is often wearisome rather than disciplinary.

Why the Earth is Round. — The mutual and equal attraction of the molecules of a substance have a tendency to make a body spherical in shape, when the molecules move upon one another freely. Thus drops of rain falling through the air are nearly or quite spherical. A drop of any liquid resting on a surface which it will not wet — as a drop of water on a greasy surface — takes a spheroidal shape. Globules of quicksilver are almost perfect spheres. Molten lead falling from the top of a tower reaches the bottom in the shape of spheres. A small quantity of oil suspended in a mixture of water and alcohol becomes a nearly perfect sphere, all because of the equal and mutual attraction of their respective molecules. In the same manner, when the earth existed in a fluid state, mutual attraction drew the molecules together, giving it nearly the form of a sphere. Under the operation of the same law, we find that nearly all the heavenly bodies are characterized by a spheroidal shape.

It is well known, however, that the earth and many of the other heavenly bodies are slightly flattened along the axis of rotation,

having the form usually known as an oblate spheroid. The manner in which the earth may have acquired this shape can be readily shown by thrusting a stick eight or ten inches long through a round ball of wet clay and whirling it between the palms of the hands. A few whirls are sufficient to make the ball of clay bulge midway between the poles.

Proofs of the Earth's Shape. — The circumnavigation of the globe by mariners is too well known to need any description in these pages. It is not a bad idea, however, to follow the voyage of Magellan's ship or that of Francis Drake *on a globe*, showing the irregular routes taken by these sailors. A route frequently taken by tourists nowadays is as follows: New York to Liverpool by steamer; railway to London and Dover, England; steamer to Calais, France; railway via Paris, Geneva, Milan, and Rome to Brindisi, Italy; steamer via Mediterranean Sea, Suez Canal (touching at Alexandria and Cairo) to Bombay; railway across India to Calcutta; steamer to Hong Kong and Canton, China, and thence to Yokohama, Japan; steamer to Honolulu, Sandwich Islands, and thence to San Francisco, Cal.; railway to New York. The minimum time in which this trip can be made is sixty-seven days.

The proof that vessels gradually sink out of sight is easier to demonstrate in theory than in practice. It requires a calm sea and a good field-glass to be satisfactorily made. It is most satisfactory when an observation can be made on several vessels at different distances from the shore. The effect is heightened when an observation is made, first at the sea-level, and then from the top of a cliff fifty or one hundred feet high.

The proof as demonstrated by a circular horizon is too difficult except with advanced pupils. In demonstrating this, it may be of service to cut sections from a sphere, from an oval body such as a lemon, and from an irregular solid. It may thus be shown that the sphere is the only solid whose sections are *always* circular, and because the plane of every horizon [1] on the earth is a circle, it follows that the earth is spherical in shape.

[1] The astronomical horizon is here referred to.

One of the most instructive proofs of the curved surface of the earth has never been mentioned in our text-books until quite recently. If an engineer's level be sighted over a pond when the water is very still, a slightly apparent curvature is at once noticeable. Place the telescope at the height of exactly four feet and sight it at a stake one mile away. The cross-wires of the telescope will strike a point in the stake, — not four feet, but four feet and eight inches above the water's level. That is, the surface of the earth has curved away from a horizontal line to the amount of eight inches. At the distance of two miles the curvature amounts to 32 inches; at a distance of three miles, 72 inches; four miles, 128 inches; five miles, 200 inches.

A very instructive demonstration which can occasionally be tried by pupils who live near the seashore has been mentioned by Professor Edward Jackson. Let three targets be fixed a mile apart on the beach at a height, say, of four feet from the water's level. If now the telescope of the level be sighted along the line connecting the tops of the two end targets, the top of the middle one will be found to be above the line. This experiment is very striking.

Another proof which may be occasionally discussed with older pupils is the nearly uniform weight of a body at all parts of the earth's surface. If the earth were not spherical, the weight of a body would vary, because *on the surface of the earth* the same body grows heavier as it approaches the earth's centre. As a matter of fact, a given weight is a little heavier near the poles than in equatorial regions, and this variation in weight has been indirectly used in determining the amount of the polar flattening.

The testimony furnished by eclipses of the moon is one of the most conclusive proofs of the earth's roundness. It will be an instructive exercise to project on the wall the shadows of differently shaped bodies, such as a cube, a cylinder, an egg, and a ball, and compare the shapes of their respective shadows. Note that the cylinder and the egg may *sometimes* project circular shadows, but that the sphere can project no other. This proof and the pre-

ceding one are regarded as the most conclusive of all. The former is strictly mathematical, the latter a physical demonstration.

One of the questions which usually confronts the teacher is, 'How can the earth be round when there are so many mountains and valleys on its surface?' This is a difficult question to dispose of in a manner which fully satisfies the pupil. One can easily comprehend the vastness of a mountain, but it is impossible to compare the mountain with the whole earth. It is not a bad idea to compare the surface of the earth with that of an orange. The pupil will not object to calling the orange round in spite of its roughness, and yet if the earth could be reduced to the size of the orange, the elevations and depressions would be only about one-tenth as high as those of the orange. A grain of sand $\frac{1}{180}$ of an inch in height would proportionately represent Mount Everest on a globe twelve inches in diameter.

The polar diameter of the earth is 7899.2 miles; the equatorial diameter is 7925.5 miles, a difference of 26.4 miles. On a globe one foot in diameter the flattening would amount to less than $\frac{1}{60}$ of an inch. Multiplying the polar and equatorial diameters by 3.1416, we have respectively 24,817 and 24,902 miles as the polar and the equatorial circumferences.

Latitude and Longitude. — The first lessons in latitude and longitude should be illustrated upon the globe. A few questions will convince the pupils that locating or describing the position of a place on a plain globe would be an impossibility. The numbered lines which we call parallels and meridians are as necessary as the names and numbers of the streets of a large city. Skilful questioning will develop the idea that two sets of lines are necessary, and that just as a city is divided into squares, so we must imagine the earth similarly divided. One set of lines are drawn through the poles, and another at right angles to these. We draw the meridians through the poles for *convenience* only. Any other point could be made to answer, but it would be very inconvenient and confusing. One could make a carriage wheel with the spokes radiating from some other point than the centre, but it would be a

very awkward wheel; we therefore find it most convenient to draw the meridians through the poles, because the latter are the ends of the axis on which the earth rotates. It will be a good plan to draw a set of meridians and parallels on the plain globe. It is unnecessary to confuse pupils by the usual finely drawn distinction between meridians and meridian circles. The main point to be inculcated is that the meridian extends from pole to pole.

The first parallel to be drawn on the globe should be the equator; and it is well to call the attention to the fact that it is so called because it separates the surface of the globe into equal parts. The other parallels may then be drawn — four or eight, as convenience may suggest — on each side of the equator.

In discussing the method of numbering the parallels and meridians, the teacher should explain how angles are measured — that is, upon the arc of a circle. Draw any angle on the blackboard, and from the point where the lines meet as a centre, draw the arcs of several concentric circles. Develop the fact that although the arcs of circles differ in length, yet they measure the same amount of angular divergence.

It is a good plan to explain that the division of the circle into 360 degrees is a matter of *convenience* only. Any other number would have answered, but 360 was chosen because it has so many exact divisors. Having explained this, it will be well to emphasize the fact that a degree does not signify a fixed length, but (in geography) a *three hundred and sixtieth part of any circumference* — whether great or small. On the earth's surface a degree measured along the equator has a length of 69.16 miles. This value decreases with increasing latitude until at the poles it is 0. It will not be amiss to drill the class in the value of fractional parts of the circle. Thus there are 90 degrees in the quadrant, and 180 in the half-circle. It is also a good exercise to drill pupils in the division of the quadrant into arcs of 10, 15, 20, $22\frac{1}{2}$, 30, and 45 degrees. Having done this, it will be easy to develop the fact that the poles are each 90 degrees from the equator, and because each pole is at the farthest point from the equator, its latitude cannot

be greater than 90°, as we now measure it. This may be shown on any terrestrial globe. Try to locate a point in latitude 100° N., along the Greenwich meridian; this distance will fall ten degrees beyond the pole and reach the 80th parallel. The two points will be 100 degrees apart, but the latitude of the point designated will be 80°.

The reason for beginning to number the parallels of latitude at the poles is obviously a matter of convenience. But why, it may be asked, should one take the meridian that passes through Greenwich, an obscure village near London, as a point from which to reckon longitude? This also is a matter of convenience. The calculation of the longitude of a place is simple in theory, but very difficult in fact, and it is done in ordinary cases by a measurement of the positions of one or more of the heavenly bodies, — the sun, the moon, or one of the stars. In order to do this it is necessary to have an astronomical observatory equipped with complete and delicate instruments for star measurement, inasmuch as the relative positions of the sun, moon, and stars must be accurately determined beforehand for every hour of the day, and every day of the year. The English people, because of their vast commercial interests, long ago recognized the necessity of establishing the latitude and longitude of all prominent localities and coast-lines, and so, to aid the work, an observatory was established at Greenwich many years ago. It was, therefore, most convenient to take the meridian passing through this observatory as a reckoning-point. Longitude is also sometimes reckoned from Washington, Paris, and Berlin, but for all practical purposes the Greenwich meridian is taken as the standard the world over.

It is well to call attention to the fact that while parallels and meridians are imaginary lines on the earth, they are real lines on maps and globes. They are essential elements of the map, and without them a map has no meaning. It is a good plan to exercise pupils in finding the latitude and longitude of a dozen or more places in order to make sure that they understand how to determine them accurately from the ordinary map. The margin of the

map is usually ruled with fine parallel lines on which the subdivisions of the degree or the distance between parallels and meridians are shown. Inasmuch as these are rarely the same for any two maps, it is proper to spend a few minutes in learning how to find the value of the subdivisions.

While pupils should be taught to determine latitude and longitude on the maps with readiness, it is a waste of time and energy to memorize the latitude and longitude of more than a very few localities. Every pupil should know the latitude and longitude of the town in which he lives, and the extent of latitude and longitude of his own state and country. It is well to use the conventional methods of expressing position which mariners and geographers have adopted; thus, the position of Washington is Lat. 38° 39′ N., Long. 77° 3′ W. The live teacher may also find many instructive questions of a general nature which will do much towards fixing the relative position of localities. For instance, a little skill in questioning will develop the fact that the central point of the United States (exclusive of Alaska) is near the intersection of the 40th parallel and 97th meridian; that, including Alaska, the United States extends from Long. 67° W. to Long. 172° E., its central meridian passing near San Francisco; that most of South America is south of the equator, and most of Africa is north of it; that the northern boundaries of New York and Wyoming are midway between the equator and the north pole; that Europe is the only grand division which does not extend to the torrid zone, etc. Exercises in the comparative latitude of places are often valuable, because our notions are so frequently at variance with the facts of the case. For instance, we almost always associate Italy with low latitude, when, in fact, it corresponds with that of the northern half of the United States. Paris is near the parallel which forms the northern boundary of the United States; and St. Petersburg is farther north than Sitka, Alaska; Calcutta, Canton, and Havana are all quite near the tropic of Cancer; and Shanghai, New Orleans, and Cairo are all near the 30th parallel. A casual investigation of the map upon which a lesson

has been assigned will always disclose a number of interesting and surprising facts. It must be kept in mind, however, that in an exercise of this kind the questions chosen should be of such a character as to develop principles rather than disconnected facts.

Motions of the Earth. — The earth has several motions.

It rotates or spins on its axis.

It revolves around the sun.

With the sun and the other members of the solar system, it forever sweeps on through space.

The axis of the earth, like that of a sleeping top, moves in an elliptical curve which is subject to constant variations.

The first and second of these motions are important in the study of geography; the others concern the study of astronomy only. It is well to mention them, however, if the pupils are advanced, but it is hardly a proper subject for lengthy discussion.

The essential apparatus required consists of a globe and a lamp. If the room can be darkened, the experiments will be much more effective. An argand or student's lamp with a silvered reflector is by far the best, but an ordinary lamp, or a candle will answer.

It is well to emphasize the fact that the earth's motions are practically constant and tolerably uniform in velocity, differing in this respect from anything that has been or can be made by the ingenuity of man. The most delicately poised wheel when revolved will come to a stop unless force is applied to keep it in motion; but the earth, and, so far as we know, every other heavenly body, is in never-ceasing motion.

Some of the questions which almost always confront the teacher are, 'What makes the earth spin upon its axis?' 'Why does it forever whirl about the sun?' 'Why does not the earth spin more and more slowly and finally stop, just as a top does?' The answers to most of these questions cannot be given with certainty, because they involve knowledge that reaches beyond the limits of modern science. To the possibilities of how these motions might have been brought about, there are added certain probabilities so strong that it will be well to discuss them.

There are many reasons for believing that the sun, earth, and all the other planets formerly existed as a mass of vapor. As the mass of vapor cooled, it also contracted in bulk; and this could take place only by the movement of the atoms which composed the mass, towards the centre of gravity. But such a movement of atoms always produces a rotatory motion. We notice this in the case of whirlwinds and whirlpools. The telescope also reveals it in the case of those masses of star-mist which we call *nebulæ*. Many of them are in the form of concentric rings, and several show a spiral structure, which could result only from a vorticose motion. As the contraction of the mass proceeded, the rotatory motion would finally become so great that some of the outer parts of the mass must be thrown off, thus forming the planets and their satellites. Because of the rotatory motion of the whole mass, any fragments which might be thrown off would also acquire the similar motion. Thus a solar system and its train of planets might be formed.

Such a description of the formation of the solar system, it must be remembered, is not science, but theory. But it may also be added that the theory rests on such strong circumstantial evidence that astronomers and geologists regard it substantially as a truth. The following are some of the principal links of evidence.

The telescope reveals masses of nebulous matter in various stages of condensation, in several instances showing concentric and spiral structure. Such conditions of matter strongly indicate rotatory motion.

The spectroscope proves that the same chemical elements which are found in the earth also compose the sun.

The sun turns on its axis from west to east, and so do all the planets. So far as is known this is true of the various satellites.

All the planets revolve about the sun[1] from west to east, and the planes of their orbits have, in all but two or three instances, only a slight difference in the angle of inclination.

[1] More accurately, the sun and all the other members of the solar system revolve about a common centre of gravity. This centre of gravity is always very near the sun, if not quite within its mass.

In discussing questions of this character, judgment and caution must be used. Pupils who are fitting themselves for teachers, however, should by all means become acquainted with those theories, pro and con, which may be found in recent treatises of astronomy.

The question of why the motion of the earth is practically perpetual, while that of the top is not, may be more easily answered. The top has a great deal of friction to check it; the earth has but very little. A top spun under water will retain its motion hardly long enough to make a single revolution; in the air and with the peg on a smooth surface, it may remain spinning several minutes; in a vacuum its motion will continue much longer, and, could we destroy *all* friction, its motion would be perpetual. The only friction that tends to retard the earth is mainly that of the tide-waves, and this is counterbalanced by a contraction in bulk, arising from loss of heat. The same is true of the rotation of the earth around the sun: there is no friction to retard it, and consequently its velocity remains unchecked.

Not infrequently some pupil will ask, 'Why does not the air check the motion of the earth?' It will be well to forestall such a question by emphasizing the fact that the air is a part of the earth, and moves with it.

The Rotation of the Earth. — The most apparent effect of the earth's rotation on its axis is the succession of day and night. It involves necessarily the phenomenon of the apparent revolution of the sun, moon, and stars in an opposite direction, and it determines the respective positions of axis, poles, equator, etc.

Hold the globe before the lamp or before a ray of sunlight reflected horizontally by a small mirror. By questioning, develop the fact that only one-half of the earth can be lighted by the sun at the same time.

Attach a wafer or a bit of paper to the globe, and slowly rotate it from west to east. The wafer reaches the lighter half of the earth, and is again turned to the darkened part. Develop from this the succession of day and of night — of sunrise and sunset; half-way between, it is either midday or midnight.

Fasten another wafer to the globe, say, ninety degrees distant *in longitude* from the first. Show from this that places, one east, or west of the other, cannot have sunrise or sunset, noon or midnight, at the same time. New Orleans and Calcutta are about 180 degrees distant in longitude. When it is noon at the former, what time is it at the latter place? What is the difference in time? London[1] is 90 degrees east of New Orleans; at which place will an observer see the sun first? How far must the earth turn before the sun can be seen at New Orleans? What time will it be at London when it is sunrise at New Orleans?

It should be impressed on the pupils that, practically, the day is the unit of time, and that the division of the day into 24 hours is one of convenience only. The same is true of the division of the hour into minutes, and of the minute into seconds. It is a good idea to drill pupils in the value of the second and the minute. A pendulum 39 inches in length vibrates seconds, and one of the proper length may easily be constructed and adjusted so as to beat seconds very accurately. Good observers train themselves to estimate short intervals of time with marvellous accuracy.

From the previous exercise or a similar one the teacher may construct an equation of time, having developed the fact that the earth makes a complete rotation of 360 degrees in 24 hours of time. The following may answer, but the teacher would best follow his own methods: —

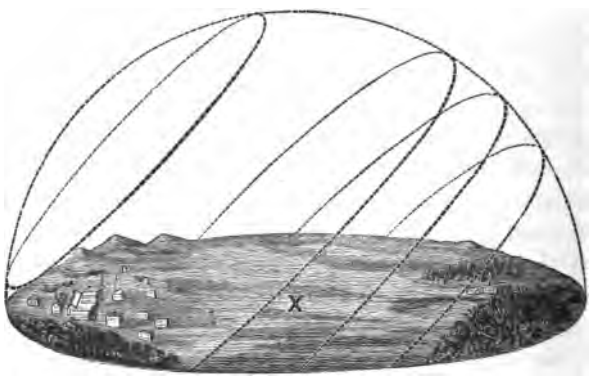
$$24 \text{ h.} = 360°.$$
$$1 \text{ h. (60 min.)} = 15°.$$
$$4 \text{ min.} = 1° \text{ (60')}.$$
$$1 \text{ min.} = 15'.$$

Pupils who have completed the ordinary course in arithmetic will easily wrestle with problems involving subdivisions of the degree, but for classes beginning the advanced or grammar school geogra-

[1] On account of the high latitude of London, it may be well — it certainly will be more accurate — to specify the time, as 6 o'clock and 12 o'clock, instead of using the terms sunrise, noon, and sunset.

phy it will be better to confine the exercises to problems which involve multiples of fifteen degrees. Before leaving the exercise, it will be a good plan to place the wafers at different latitudes in the same meridian, and show by experiment that all places at the same meridian have the same clock time.

Perhaps the most instructive lessons on the earth's daily motion may be learned from the stars. The first effort in this direction should be to acquaint the pupil with the constellation Ursa Major, more commonly known as the 'Dipper.' The two stars forming the front side — that is, opposite the handle — are called 'pointers,' and



Apparent Daily Motion of Sun — Observer at Lat. 45°.[1]

a line extended from bottom to top through these stars points very nearly to the north, or pole star. By carefully watching the stars in this part of the heavens on a winter's night, we shall find that the pole star is apparently stationary, but the stars which appear to be near seem to be revolving about it. By watching for six hours, we shall find that these stars have apparently travelled one-fourth the distance around the pole star. We shall find, moreover, the stars near the poles never pass below the horizon, while those at a dis-

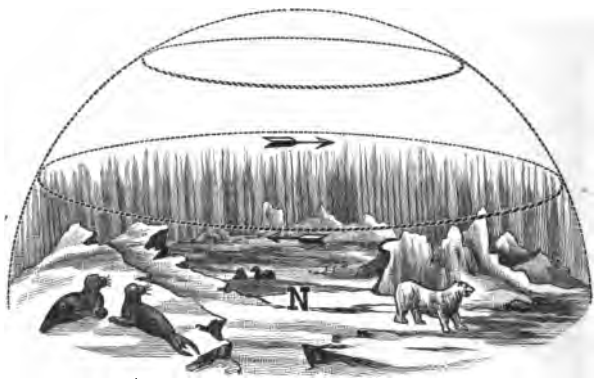
[1] This and the following cuts are taken by permission from Professor Jackson's 'Earth in Space.'

tance of 40 degrees or more (in the latitude of New York) appear to rise and set just as the sun does.

It may be well to discuss the velocity with which a body moves, as affected by the earth's rotation. The velocity of a point at the equator can be easily computed; as it travels at the rate of about 25,000 miles in 24 hours, a little more than 1000 miles per hour. At the poles the velocity becomes 0, and at intermediate latitudes it varies between the rates mentioned. A moment's consideration of these values is sufficient to show the most conservative pupil that the earth is not whirling about in the air, — an idea which, singularly, becomes firmly fixed in the minds of many pupils. It is hardly necessary to add that with the earth whirling at the rate of 1000 miles per hour, we should have a constant breeze in equatorial regions about ten times as strong as the wildest hurricane. The difference of velocity between equatorial and polar regions might be discussed with classes; for, as the pupil will afterwards learn, it has much to do with the direction of constant winds. Except with mature pupils, however, it would be hardly wise to go too minutely into this part of the subject until it is taken up in physical geography.

In the preceding exercises the teacher may use his judgment as to the position of the earth's axis. It may be advisable at first to hold the globe so that the light from the lamp or from the sun reaches from pole to pole. Before leaving the subject, however, it is essential to impress the fact that the position and direction of the earth's axis have much to do with the condition of the earth in respect to length of day, temperature, and change of seasons. This may be readily seen by the following experiments. Incline the globe so that the north pole points towards the light and revolve it. By questioning, develop the fact that the northern hemisphere receives all the light, while the southern hemisphere is in perpetual darkness. Elicit the fact, also, that the light and heat would be most intense at the pole and least intense at the equator. Show that the sun will always be directly overhead at the pole, and that it will appear to skim along the horizon at the equator. Before leaving the ex-

ercise, it would be well to set the axis of the globe at an inclination of $23\frac{1}{2}$ degrees from a perpendicular to the plane of the ecliptic, holding the globe so that the north pole leans towards the sun. It may require some little tact in questioning, but the class should be led to discover the fact that a circle extending $23\frac{1}{2}$ degrees from the north pole constantly receives light from the sun, no matter in which way the globe may be turned. Do not *tell* the pupils this, but lead them to discover it. This will develop the fact that there are parts of the world in which the day lasts much longer than the period which we know as day-



Apparent Daily Motion of Sun — Observer at the North Pole.

time in temperate latitudes. It also leads to a consideration of the yearly motion of the earth, the change of seasons, and the discussion of the varying lengths of day and night.

In all ordinary uses of the globe, do not fail to have its normal position with the axis pointing north and south, and inclined at such an angle that it is parallel to the axis of the earth. It may be necessary to tip the frame of the globe slightly to accomplish this, but this can be easily managed. All movements of the globe should be made from this position as a basis. In sunny days it is an excellent plan to carry the globe out of doors, and, after setting it in the proper position, study the positions of the actual shadows.

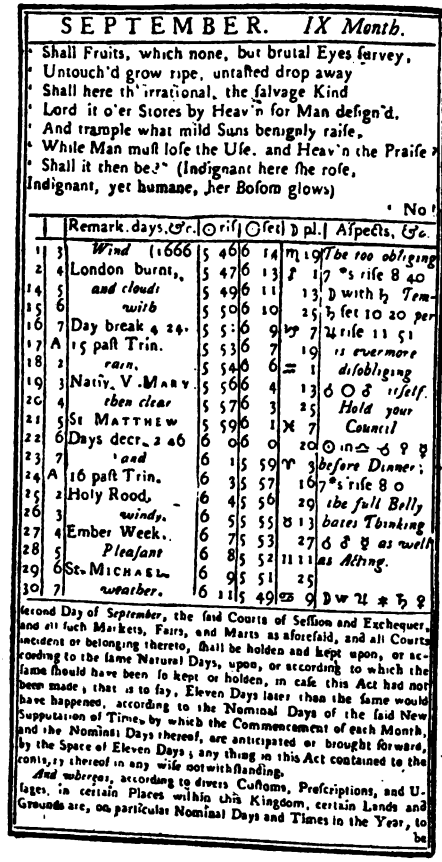
The Earth's Yearly Motion. — The earth, like the other planets, is forever whirling around the sun. While making a complete revolution around the sun, it rotates about $365\frac{1}{4}$ times on its axis. Call attention to the fact that the only convenient way of estimating the yearly motion of the earth is by expressing it in so many rotations upon the axis. These motions of the earth are, in fact, the only convenient measures of time, and they have been used as such ever since people have lived on the earth. Call attention to the fact that nearly all our common measures, those of the metric system excepted, are based upon the length of the day or of the year. For instance, the yard is a certain fractional length of a pendulum which beats seconds. The gallon and the bushel are volumes which can be expressed only by the subdivisions of the yard; the pound, whether troy or avoirdupois, is the weight of a certain measured volume of water. It is a good plan to dwell on the fact that the year is not an even measure of the day, and that while the former is usually called $365\frac{1}{4}$ days, yet practically (and legally) 365 even days is the length of the year for three successive years, the fourth year having 366 days. But the exact length of the year is 365 d. 5 h. 48 m. and 47 s. The fractional part of the day is therefore not quite one-fourth of a day, and to add the extra day every four years would carry calendar time ahead of true time. This is counterbalanced by dropping the extra day in all even centuries except those which are divisible by 400. Thus, the year 1900 will have but 365 days, while the year 2000 will have 366 days. Except as noted, the extra day is added to the number of the year which is evenly divisible by 4, as 1876, 1892, etc.

Before the time of Julius Cæsar, the length of the year had been commonly taken as 365 days. But even at Cæsar's time the error had become noticeable, and Cæsar partly corrected it by adding the extra day to every fourth year, thereby establishing the leap year. This circumstance gave rise to the 'Julian' Calendar.[1]

[1] The Romans divided the month into three parts, called respectively the Ides, the Nones, and the Kalends. Hence the origin of the expression *Calendar*. Cæsar also redivided the year, adding two more months. Hence the apparent inconsistency of calling September the *seventh* month, etc.

But the difference between 365 d. 6 h. (365.25) and 365 d. 5 h. 48 m. 47 s. (365.2422) finally involved so much error that in 1582 Pope Gregory XIII. changed the Calendar again in order to bring Easter and the various other church festivals nearer to their proper date. To this end he omitted ten days, or rather set the Calendar date ten days ahead, and improved Cæsar's Calendar by decreeing that even centuries, except those divisible by 400, should not be leap years. Most of the countries of Europe have adopted the new or Gregorian Calendar. In England it was not adopted until 1752, and in Russia it has never been adopted, the Julian Calendar being still in use. The difference in time now amounts to 11 days. Thus, the 16th of July in New York or London is the 5th of July in St. Petersburg. For many years after the adoption of the Gregorian Calendar in England, it was customary to express the dates by both methods, in order to prevent confusion. Thus, in the English editions of Macaulay's History we find dates expressed $\frac{\text{Feb. } 3}{13}$, $\frac{\text{July } 27}{\text{Aug. } 6}$. Even at the present day, correspondents writing from Russia, and using the Julian Calendar, commonly affix the abbreviation O. S. (old style) to all dates.

With younger pupils it would be perhaps unwise to discuss the technical terms involved in the earth's annual motion, such as plane of the ecliptic, the ellipse, the eccentricity of the orbit, etc. It would be well, however, with older pupils to instruct them in the difference between the ellipse and the circle. It will not be amiss, either, to teach pupils how to draw an ellipse. The chief and only difficulty lies in the fact that a drawing-board is essential, inasmuch as it is necessary to drive two or more pins through the paper, and to set them quite firmly into the board. This, of course, is out of the question where the drawing-paper rests on the pupil's desk, unless the latter be cloth-covered or of rough pine: it is also difficult on a slated blackboard. A piece of smooth pine board, or even a piece of thick pasteboard, will answer all purposes, however. The figure that the earth describes in its journey around the sun is an ellipse, but it is so near in shape to a circle that close measurement is required to detect its shape. It



SEPTEMBER. *IX Month.*

' Shall Fruits, which none, but brutal Eyes ſervey,
' Untouch'd grow ripe, unraſted drop away
' Shall here th' irrational, the ſalvage Kind
' Lord it o'er Stores by Heav'n for Man deſign'd.
' And trample what mild Suns benignly raiſe,
' While Man muſt loſe the Uſe. and Heav'n the Praiſe?
' Shall it then be?" (Indignant here ſhe roſe,
Indignant, yet humane, her Boſom glows)

' No!

		Remark. days. &c.	☉ riſ	☉ ſet	☽ pl.	Aſpects, &c.
1	3	*Wind* (1666	5 46	6 14	♏ 19	*The too obliging*
2	4	London burnt,	5 47	6 13	♐ 1	☽ ☍ ♄ riſe 8 40
14	5	*and cloudy*	5 49	6 11	13	☽ with ♄ *Tem-*
15	6	*with*	5 50	6 10	25	♄ ſet 10 20 *per*
16	7	Day break 4 24.	5 51	6 9	♑ 7	♅ riſe 11 51
17	A	15 paſt Trin.	5 53	6 7	19	*is evermore*
18	2	*rain.*	5 54	6 6	♒ 1	*diſobliging*
19	3	Nativ. V. MARY.	5 56	6 4	13	☽ ☉ ☌ ♂ *itſelf.*
20	4	*then clear*	5 57	6 3	25	*Hold your*
21	5	St MATTHEW	5 59	6 1	♓ 7	*Council*
22	6	Days decr. 2 46	6 0	6 0	20	☉ in ♎ ☌ ♀ ♆
23	7	*and*	6 1	5 59	♈ 3	*before Dinner;*
24	A	16 paſt Trin.	6 3	5 57	16	☽ ☍ ♃ riſe 8 0
25	2	Holy Rood,	6 4	5 56	29	*the full Belly*
26	3	*windy.*	6 5	5 55	♉ 13	*bates Thinking*
27	4	Ember Week.	6 7	5 53	27	☽ ☌ ♀ *as well*
28	5	*Pleaſant*	6 8	5 52	♊ 11	*as Acting.*
29	6	St. MICHAEL.	6 9	5 51	25	
30	7	*weather.*	6 11	5 49	♋ 9	☽ ☍ ♅ ✶ ♄ ♀

Second Day of *September*, the ſaid Courts of Seſſion and Exchequer, and all ſuch Markets, Fairs, and Marts as aforeſaid, and all Courts incident or belonging thereto, ſhall be holden and kept upon, or according to the ſame Natural Days, upon, or according to which the ſame ſhould have been ſo kept or holden, in caſe this Act had not been made; that is to ſay, Eleven Days later than the ſame would have happened, according to the Nominal Days of the ſaid New Supputation of Time, by which the Commencement of each Month, and the Nominal Days thereof, are anticipated or brought forward, by the Space of Eleven Days; any thing in this Act contained to the contrary thereof in any wiſe notwithſtanding.

And wherean, according to divers Cuſtoms, Preſcriptions, and Uſages, in certain Places within this Kingdom, certain Lands and Grounds are, on particular Nominal Days and Times in the Year, to be

Fac simile of a page from 'Poor Richard's' Almanac, 1752, showing the precession of the Calendar, the date having been advanced from Sept. 2 to Sept. 14. By reference to the second column it will be observed, that while 4th day was the second day of the month, 5th day was the fourteenth. The paragraphs at the bottom of the page are part of the Parliamentary Enactment fixing the dates for public gatherings, sessions of courts, maturing of contracts, etc.

Furnished by courtesy of the Philadelphia Library. Photographed by Mr. W. W. Randall.

is not a bad idea to have the orbit or earth's path drawn on scale, and once prepared to draw the ellipse, any number of ellipses varying in eccentricity may be drawn.

Fasten a sheet of white or of good manilla paper to the smoothed side of a pine board not less than 13 inches wide. In about the centre of the paper drive two small pins one-tenth of an inch apart into the board so that they set firmly. Fasten the end of a thread a little over 12 inches long to each pin so that there is, as nearly as can be measured, 12.1 inches of thread between the knots. Now subtend the thread with the point of the pencil, and beginning at one side, in line with the pins, allow the subtended thread to guide the pencil point until half the ellipse is drawn. In a similar manner finish the other side. This ellipse is practically a reduced orbit of the earth on scale. By varying the length of the thread and the distance between the pins, other ellipses may be drawn. The two pins are called the *foci* (sing. *focus*) of the ellipses, and the distance between the foci is its *eccentricity*. If we imagine a vast level surface without thickness to extend through space in such a position that the earth's orbit could be drawn upon it, or that the orbit everywhere touched it, this figure will be the plane of the ecliptic.

It is a difficult matter to explain just what is meant by the plane of the ecliptic without a physical illustration. A good way of illustrating it is to suspend a cheap globe, or one made for the purpose, in water. Thrust a wire or a knitting-needle through a ball on which the equator, tropics, and polar circles have been drawn. Hold the ball by the axis in a shallow vessel of water so that the surface of the water touches the equator. The surface of the water represents the plane of the ecliptic, and in this position the latter corresponds exactly with the plane of the equator. Now incline the axis until the surface of the water just touches the tropical circles. If the latter be drawn in their proper places, the inclination of the axis will amount to $23\frac{1}{2}$ degrees. This shows the true relative position of the earth and the plane of the ecliptic. Note the fact that this plane crosses the equator in two places 180 degrees apart.

Change of Seasons. — If the foregoing points have been made clear, the pupils are now ready for the explanation of the change of seasons. Before beginning the series of experiments it will be well to refer to the fact that the earth's axis points always in the same fixed direction,[1] and that it keeps parallel to itself in all parts of the orbit. It will be well, also, to review the previous lessons in which it has been shown that the most warmth is received in those places where the sun's rays fall vertically, and the least where they strike the earth obliquely. Now prepare the lamp and the globe, darkening the room if possible. Place the globe at the same height as the lamp, and incline the axis so that the north pole leans $23\frac{1}{2}$ degrees towards the light. Question the class until the fact is apparent that the sun's rays reach $23\frac{1}{2}$ degrees beyond the north pole, and that they are nearly vertical in most of the Northern Hemisphere. Note, also, that while in this position, all that part of the surface within a distance of $23\frac{1}{2}$ degrees is not turned away from the sun at any time during the twenty-four hours. Note the additional fact that parts of the earth without the circle are bathed by the sunlight for the greater part of the time during the earth's rotation.

From this exercise two important facts bearing upon climate may be impressed on the class. First, the sun's rays are vertical, or nearly so, on a large part of the Northern Hemisphere. Second, all the Northern Hemisphere receives sunlight from thirteen to twenty-four hours of the day. Therefore, because the sun's rays are so direct, and because every part of the Northern Hemisphere is receiving heat and light more than half the time, it is the warm or summer season in this hemisphere. By judicious questioning, lead the pupils at this point to discover that the Southern Hemisphere receives much less light and heat, and that the surface within a distance of $23\frac{1}{2}$ degrees receives no sunlight at all while in the position represented by the globe.

Carry the globe half-way round in its extemporized orbit, taking

[1] There is a slight but uniform change which becomes apparent only after long intervals of time. This will be noted elsewhere.

care to keep the axis parallel to its former position. An inspection of the globe will show that the conditions of light and heat are very different from what they were when the earth was in its former position. Lead the class to discover that the north pole now inclines $23\frac{1}{2}$ degrees away from the sun. Note that all that surface around the north pole to a distance of $23\frac{1}{2}$ degrees from it receives no sunlight at all. Develop the fact that beyond this circle the sun shines less than half the time on any part of the Northern Hemisphere while the earth is in this position. The great difference between the heating power of vertical and oblique rays may here be shown. It will be seen that a given number of rays falling obliquely may cover, say, twice the area they would if they descended vertically.

With the foregoing experiments it will be easy to clear away any misapprehension of the fact that with summer in the Northern, there must necessarily be winter in the Southern Hemisphere. It will undoubtedly heighten the interest and make a lasting impression if the teacher can procure a copy of the log of some vessel plying between New York and Buenos Ayres, selecting a sailing some time in February or August.

The two foregoing exercises show the relative position of the axis of the earth in June and December — the seasons of maximum heat in the Northern and Southern Hemispheres. It may be well in the judgment of the teacher to pass over the intervening positions in March and September. Perhaps in the majority of cases it would be unwise to make any mention of the spring and the autumnal equinox. It may not be confusing, however, to call the pupils' attention to the fact that in March and September the sun's rays are less slanting than in June, and more slanting in December (if we take the Northern Hemisphere). This will be evident from the fact that they reach exactly from pole to pole. The days and nights being now of equal length, every place receives as much heat during the day as it does during the night. It will be proper to mention here a fact that will be more fully discussed in the notes on physical geography; namely, that the seasons as we best

know them in the eastern and interior parts of the United States are either greatly modified or have no existence in other parts of the world (see p. 120).

It is a very difficult matter to show graphically the apparent north and south motions of the sun, because the sun requires six months to complete a single oscillation. On some clear day of June, at midday, pupils may be directed to estimate the height of the sun from the southern horizon, and the same may be again done in December. The difference in the height of the sun will at once be apparent. If a pole ten or twelve feet high be erected in the school yard, its shadow, at noon, will gradually decrease in length from January to July, and increase from July to January. Stick a pin lightly into the globe somewhere in the north temperate zone, and carry the globe around the lamp, keeping the axis in its proper position. By repeating the experiment under different conditions, the following general laws may be experimentally shown, the pupil in each case making his own deductions:

In the north temperate zone the noon shadows fall towards the north; in the south temperate zone, towards the south.

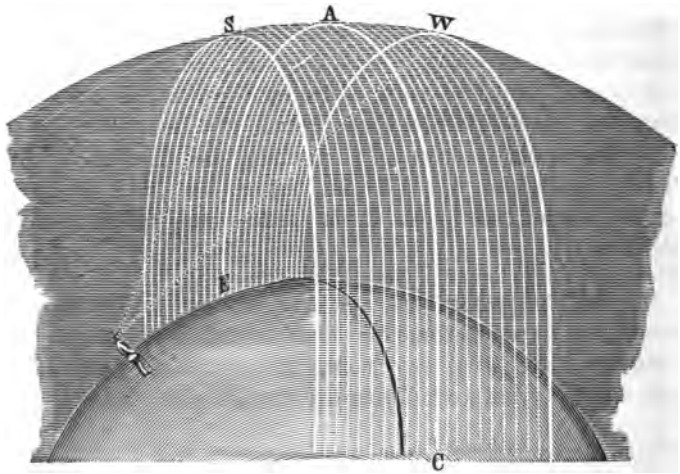
In the torrid zone the noon shadows fall towards the south during the first half, and north during the last half of the year.[1]

From these experiments it may be shown that if an observer stand at the equator and watch the sun at noon each day of the year, the sun will appear to swing northward and southward a distance of $23\frac{1}{2}$ degrees from the zenith point, a total oscillation of about 47 degrees. In the latter part of March (say) the sun is directly overhead. Day after day it goes northward until the latter part of June. Then it seems to be stationary (the summer solstice or *sun-standing*), and immediately afterward swings back in an opposite direction. In the latter part of September it is

[1] The discussion of the shadows in the frigid zones will be apt to prove somewhat confusing to pupils. Being immaterial, it may be omitted.

overhead again, and in December it has gone 23½ degrees southward, when it stops (winter solstice), and turns northward.

Except with very mature pupils, it is doubtful whether any attempt should be made to use the terms 'summer' and 'winter solstice' or 'spring' and 'autumnal equinox.' All of these words are loosely used, and are properly used in the Northern Hemisphere only. The summer solstice of New York is the winter solstice of Melbourne. The same is true of the spring and the autumnal equinox.



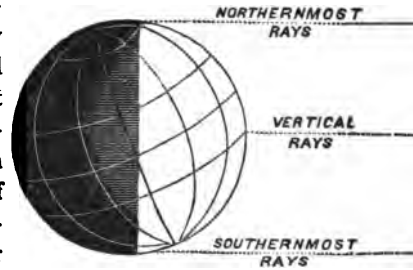
The Apparent Yearly Motions of the Sun North and South of the Equator.

By this time the pupils will be ready to understand why the tropical and polar circles are drawn each in its particular position on the globe. The following facts should be developed by questioning, together with the use of the globe. The pupils themselves should be required to fix the globe in its proper position.

The Arctic Circle marks the farthest limits to which the sun's rays reach on the 21st of June; the Antarctic Circle marks these limits on the 21st of December.

The Tropic of Cancer marks the farthest point at which the sun is directly overhead at noon in the Northern Hemisphere; the Tropic of Capricorn, a similar point in the Southern Hemisphere.

The length of the day, that is, the duration of sunshine at different latitudes, is a matter of interest and importance. A mathematical calculation is necessary to determine this with accuracy, but the accompanying diagram will show graphically the main principles involved in estimating the longest day of the year. The diagram shows the earth in its position on the 21st of June, the shaded part representing night; the lighter part, day. At the Arctic Circle, Lat. 66° 32′, all the earth is within the illuminated half of the earth, and the day is 24 hours long. At Lat. 0° the equator is seen to be half in the illuminated and half in the shaded part; the days and the nights are therefore each 12 hours long. In any latitude, that fractional part of the parallel in the illumined half of the earth, reduced to 24ths, shows the length of the longest day.



Length of Day.

Other Motions of the Earth. — The motion of the earth with the rest of the solar system in space is one which it is out of place to discuss in these pages. It is only within a few years that this motion has been known, and its velocity and direction are largely questions of speculation. Recent discoveries have shown that the stars of the constellation of Hercules are apparently spreading apart, and it is therefore thought that the solar system is moving in this direction. The velocity is estimated at 1,382,000,000 miles per year by Bessel, and 149,000,000 miles by Struve.

The axis of the earth, like that of a sleeping top, is slowly swaying — bending over successively in every direction, and describing an elliptical curve. This motion, which amounts to only a few

minutes of arc each year, causes the phenomenon known as the *precession of the equinoxes.* The direction of the axis is gradually receding from the present north star by a small but measurable angular rate, and it is estimated that about 26,000 years are required to complete the cycle. When the axis has half completed its round of swaying, the seasons will be reversed. The Northern Hemisphere will have its mid-winter in June and its mid-summer in December. Its winters will be a little longer than its summers, and the ice-cap, which is now decreasing, will perhaps once more creep southward and cover the continents until they are again shrouded in a long glacial winter.

In discussing the motions of the earth it will be well to avoid any mention of *centrifugal* and *centripetal* forces, as these terms are not only misleading, but often erroneously used. It is a fundamental proposition that a body in space once in motion will move forever in a straight line unless its direction is deflected. Now the direction in which the earth moves is constantly deflected by the attraction of the sun; and the attractive force being approximately uniform, the earth is falling towards the sun in exactly the same velocity that it is projected through space. The balancing of the two produces the rotatory motion of the earth around the sun.

PART II.

MODERN FACTS AND ANCIENT FANCIES.

VII.

GEODESY AND OROGRAPHY.

The Shape of the Earth. — Recent geodetic surveys have developed many interesting and striking facts concerning the shape of the earth. The surveys show that the earth is not a true oblate spheroid, but that it closely resembles a cylinder with the corners rounded off. In other words, the earth has that square-shouldered shape which astronomers find to be common also to Jupiter and Saturn. Between the 20th and 30th parallels the waters of the ocean are estimated to be a little more than ten metres higher than their normal level; that is, the surface of the water is forty feet farther from the centre of the earth than it would be were the earth a true oblate spheroid. It is shown also that a number of protuberances exist on various parts of the surface which distort its shape. These irregularities are slight, but they are nevertheless measurable.

The Interior of the Earth. — All students of geology now admit that the theory of an earth with a liquid interior surrounded by a solid crust is untenable. The earth in its relation to the laws of gravitation behaves like a solid body, 'as rigid as a globe of glass,'[1] and not like a liquid surrounded by a thin crust. It must not be inferred, however, that this view precludes the existence of a highly heated interior. On the contrary, a heated interior is fully in accord with the laws of gravitation. But liquefaction de-

[1] On the authority of Sir William Thomson.

pends on pressure as well as temperature, and the enormous pressure of the outer parts of the earth prevents the heated interior from taking a liquid form.

It is evident upon a moment's thought that an earth having a crust only forty or fifty miles thick would present but little stability to a force so enormous as the attractive force of the sun and the moon. There would be not only tide-waves of water but also tide-waves of the earth's mass itself. Such a tide-wave might be exceedingly small, but yet both the advance and the recession of the wave would be marked by severe earth-shocks caused by the bending and crushing of the strata.

It is also held by the most advanced geologists that volcanoes are not necessarily channels reaching into the general interior, but rather into local, subterranean reservoirs of heated matter. 'A few geologists, however, find a compromise in the view that there exists a semi-liquid stratum between a solid crust and a solid nucleus.'[1]

Changes of Elevation. — Observations covering a period of more than one thousand years demonstrate that all parts of the earth's surface are undergoing more or less change of elevation. A few of the more remarkable instances of subsidence and elevation are herewith given on the authority of Dana.

The coasts of Sweden and Finland are slowly rising. The rise is noticeable at Stockholm, but increases to the northward. It is apparent as far north as North Cape. Careful estimates made by the government show that the rise at Uddevalla amounts to about four feet per century. In the extreme southern part of Sweden there is evidence of a slight subsidence.

On the western coast of Greenland a slow subsidence is taking place. From Disco Bay to the Bay of Igaliko, a distance of five hundred miles, the subsidence has been so great that buildings along the coast have been entirely submerged, and former islands are now covered with water.

There is also evidence that the Labrador coast is undergoing

[1] Le Conte.

slight changes in level, sinking in the vicinity of Baffin Bay, and rising towards the south. It has been found that a subsidence is taking place along the coast of New Jersey, which, according to Prof. G. H. Cook, State Geologist, has amounted to about five feet in the past sixty years.

The coast of British Columbia and the vicinity of Puget Sound have been raised notably since the close of the glacial period. A more remarkable case of elevation has occurred off the northern coast of Asia, in the vicinity of Nova Zemlaia and Spitzbergen. 'These lands have in many places been raised three hundred feet or more, channels have been blocked, and islets off the shore have, within the memory of man, become joined to the land.' [1]

Continents. — The confusion in the use of the word 'continent' in its geographical sense is apt to give the teacher no little annoyance. In many of our text-books, Europe, Asia, Africa, and all the other great masses of land are each recognized as continents. In other text-books only two continents, the Eastern and the Western, are described. Almost all modern geographers make a broad distinction between continents and grand divisions of land. Thus the two grand divisions, North America and South America, constitute the Western Continent. Africa and Europe-Asia or Eurasia form the Eastern Continent. Australia with the outlying island of Tasmania is called the Australian Continent. The island chains which skirt the shores of the continents are not improperly included as parts of the continent near which they lie. Most of these islands are partly submerged mountain-ranges, and in many instances their relation and physical connection to the adjacent continent may be readily traced.

This is very apparent in the case of the Aleutian Islands, which are a continuation of the peninsula of Aliaska; it is equally apparent in the case of the Sunda Islands, which are the tops of a range parallel to the Malay Peninsula. Indeed, the whole Malaysian Archipelago is thoroughly Asiatic, not only in flora and fauna, but also in geological history. Greenland, which is usually and prop-

[1] Prestwich.

erly included with North America, has, singularly, a flora and fauna resembling those of Europe, rather than those of the Western Continent.

Europe and Asia form a single body of land, to which the name Eurasia or Europe-Asia is now commonly given. There is no reason whatever for considering them as two different land-masses, for the line which is supposed to divide them is purely an imaginary one. It has not even the merit of being a surveyed line, and it is in no respect a physical boundary, for there are no characteristic features separated by it.

Africa is a peninsula attached to Eurasia, and not an island. The Suez Canal, a narrow and shallow ditch, does not give Africa an insular character which it did not previously possess. Chains of rivers, canals, and lakes in a dozen instances separate parts of the United States and of Europe, so as to surround them with water, but one would hardly call such divisions islands, in a geographical sense. It is equally absurd to call Africa an island.

The Isthmus of Suez, which connects Africa to Eurasia, although more than three times as broad as the Isthmus of Panama, presents none of the physical features of the latter. The latter is a mountain-range whose lowest crest is not far from three hundred feet above mean tide-water; the former is a low sand-spit which has much the appearance of having been formed by the winds and waves. A chain of brackish lagoons extends part way across it, and marks a line of depression which formerly was a canal. One of the proofs by which archæologists endeavor to connect Rameses the Great, the persecutor of Joseph, with Sesostris, hinges upon the canal that Rameses is asserted to have made. It is certain, however, that Rameses did construct one of these famous waterways. This was the canal which connects the Red Sea with the Pelusiac branch of the Nile. It began about fifteen miles northeast of Bubastis, from which point to the Red Sea its course was nearly one hundred miles long. The remains of an ancient town on the line of this canal bear record both to the existence of the canal and to the builder. Then, as now, the shifting sands were

the greatest enemy the engineers had to contend with, and the canal appears to have repeatedly silted up. It was reopened, however, by Necho, by Darius, and by Ptolemy. According to Herodotus, Sesostris 'fitted out vessels on the Red Sea, and was the first who went beyond the straits into the Indian Ocean.'

The question of the continental character of Australia is occasionally a subject of discussion, the counter claim being as to whether it is not more correctly classed among islands. If ocean surroundings are all that are required to make an island, then Australia is certainly an island. So also are North America and South America, and Eurasia. But to the geographer, the continent possesses other features beyond mere continuity of shore-line. It has definite shape and structure, and distinctive features of relief, fauna, and flora. Australia shows these features in a marked degree. The chief distinguishing features are the flora and fauna. These are totally different from the flora and fauna of any other part of the world, and they alone are sufficiently specific to entitle Australia to be classed among the continents. The chief lack of Australia is a range of mountains in the interior, sufficiently high to condense the moisture of the ocean winds. For want of it the greater part of the continent will always be a desert.

In the opinion of the geologist, Australia is regarded as the almost sole surviving remnant of a pre-geological age. Although its flora and fauna are not especially related to the fossil flora and fauna of other continents, yet they are highly indicative of the types of a former age. In seeming consistency with its old age, most of the continent is sinking[1] — nearly every part in fact except the southern coast. This area of slow submergence embraces also the greater part of the Caledonian chain of islands.

Mountains. — The ordinary definitions about mountain-ranges and mountain-systems are often erroneous. Usually these definitions run about as follows: 'A mountain-peak is a elevation of land rising much higher than the surrounding country.' 'A mountain-range consists of a number of mountains nearly in a line.' 'A

[1] Prestwich.

mountain-system is a collection of ranges.' Let us examine these definitions.

The first one leads us to infer that the mountain is a single elevation rising above a plain or a lowland region. This is scarcely ever the case. Isolated mountain-peaks are of very rare occurrence, and they are nearly, if not always, volcanoes. The second definition asserts that the mountain-range is a line of peaks, stringing one after another. This is never the case. A mountain-range is essentially a fold or wrinkle in the earth's crust. The top or crest of the range is usually uneven, and any part of it which is obtrusively higher than the general altitude of the crest is a mountain-*peak*. A mountain-system comprises all the highlands belonging to a general elevation. It includes not only the ranges, but also the plateaus and cross-spurs which go to make up a great elevation.

Usually the ranges are parallel, but in many instances spurs extend from the various ranges in such a way that the crests form a complex network. Instances of this kind are frequently observed in the Rocky Mountains, the Andes, and the Alps. In the Appalachian system, however, the ranges are unusually regular, but even here the various folds or ranges are not continuous throughout the whole extent of the system. A range extends a greater or less distance and disappears; and as one disappears, another takes its place, rising possibly to the right or to the left.

Perhaps the most prevalent idea concerning the formation of mountains is that they are composed of matter thrown out of vast fissures and piled up in the form of a long wall. This extrusion of molten rock should certainly not be rejected in the consideration of orographic geology, but, nevertheless, it is practically unimportant. The mountain-range has been formed by side or lateral pressure, and, excepting an occasional igneous dyke, is composed entirely of folded strata of sedimentary rock. In some instances the folding or wrinkling has been quite simple and regular; in others there has been very complex mashing and crumpling of strata.

It must not be inferred, however, that the formation and uplift of the mountain-fold was a matter of short duration. In some mountainous regions the upheaval is still going on, and the breaking and crumbling of the strata give rise to the phenomena of earthquakes. In at least one range, the Uinta, we may gather some idea of the rate of uplift. Green River has cut its way transversely across this range. Now it is not to be supposed that the river flowed point-blank against the escarpment of the range until it had cut a channel nearly a mile from top to bottom, rather than to flow around the mountains. On the contrary, the river has always had the right of way there. It flowed in precisely the same channel before the uplift of the Uinta Mountains began, and the uplift was not faster than the corrasion of the river.

There is some little confusion in the use of the terms *plateau* and *table-land* which has arisen for want of common agreement as to what should be specifically embraced under each name. Unfortunately there is no fixed custom in the use of the terms, and the best that can be done is to follow the usage which common sense suggests. Formerly these words were synonymous, but latterly the term *table-land* has been applied to flat-topped mountains as well as to general elevations — a modification of the term which is unwarranted. In the general sense the plateau or table-land is any extensive elevated region of either flat or hilly surface. It may flank a mountain-range, exist as a pass between the extremities of two ranges, or be a high valley between parallel ranges. It is of course impossible to fix a precise height above which a surface shall be called a plateau, but any extensive surface several hundred feet higher than the adjacent country might properly be called a plateau, if marked by a decided or an abrupt slope, while a surface considerably higher might be regarded as a plain. The 'Plains' west of the Missouri River are properly considered as a plateau; so also is the Basin Region between the Rocky and the Sierra Nevada Mountains.

The Spanish word 'mesa' (*mā'sä*), a table, is now almost usually given to the flat-topped formations of the Western Continent.

The mesa is always surmounted by a cap of rock, sometimes sedimentary, and sometimes of lava. It is in every case the result of erosion. The surrounding country has been scored with deep, water-worn valleys, the mesa being the only part that has not been worn away by the weathering forces of nature. The terraced slopes along the cañons of the Colorado River show in a most striking manner how the mesas are formed, and the nearly level country scored by these deep cañons are excellent types of the mesa.

Although mesas are commonly spoken of as *mountains*, it should be borne in mind that they have none of the characteristics of mountains. The true mountain-range is a fold. The mesa, on the contrary, is distinguished by horizontal strata, which have been but little disturbed by plication or folding. On maps the mesa lands are represented by the same hachure lines that conventionally represent mountains — an unfortunate plan which in not a few instances has given rise to the idea that these cliffs are mountains. The same erroneous idea prevails with reference to the *mauvaises terres*,[1] or 'bad lands,' which are so common in parts of Dakota, Montana, and Nebraska. The bad lands have been formed mainly by running water. The soil of these formations being very light and fine, is therefore easily carried away by water. In many instances small streams of water in recent geological times have worn these deep gorges.

There is also some confusion in the nomenclature of mountains, the terms *ridge*, *range*, *chain*, and *system* being often loosely used. As commonly used by geologists a *range* is a flexure or fold of the strata, while the action of water, ice, etc., wears the

[1] The use of this word is unfortunate. It implies that the whole region is desolate and worthless for agricultural purposes; and this, indeed, is a very widespread impression. As a matter of fact, the bad lands are unusually fertile. They derived their name from the description of an old French explorer, who asserted them to be *mauvaises terres pour traverser*. This, through the Yankee characteristic of brevity, became shortened into the misleading term 'bad lands.' The region seems to have been at one time a great lake. When the basin filled and overflowed, the outlet, in time, cut its way so deep that the lake was entirely drained.

surface of the range into *ridges*. Occasionally we find several ranges which are parallel (or in consecutive lines) and quite so near together as to suggest that they were formed at the same period. Le Conte and Dana used the term *chain* to indicate such a group of ranges. Thus the Blue Ridge and the Alleghany Mountains are parts of the Appalachian Chain; the ranges of the Rocky Mountains proper form the Rocky Mountain Chain. In the United States this use of the word *chain* is becoming quite common, but English geographers generally use the word *system* to denote such a cluster of ranges. This is unfortunate, because in the United States the word is used to denote all the mountains in the whole great belt. Thus all the western highlands of North America form the Rocky Mountain *System;* all the eastern the Appalachian *System*. Because of this double use of this term, it has been proposed to use the term *cordillera* instead, but as yet the word has not come into general use.

The Exaggeration of Slopes. — Another improper conception of mountains is the result of faulty pictures. We are apt to outline the slopes of a mountain at angles of from forty to sixty degrees in inclination, measured from a horizontal line. As a matter of fact, such slopes as these are almost unknown in orography. A few volcanic cones have slopes approaching forty degrees near their craters, but these are rare instances. The slopes of such peaks as Mont Blanc, Mts. Whitney, Shasta, Hood, and St. Elias do not exceed ten or twelve degrees, although there are cliffs along their flanks with very steep escarpments. The Matterhorn, Jungfrau, and other Alpine crags are considerably steeper, but the inclination of their slopes is by no means so great as is usually represented. In the engravings of a well-known painting the slopes of the Matterhorn are not far from sixty-five degrees in inclination; a photograph in the author's possession shows that even the surmounting pinnacle (the 'horn') of this Alp has a slope of hardly more than one-half that portrayed in the engraving.

The pictures of Cotopaxi furnish another example to the point.

Until within two or three years all the illustrations of this volcano have been copied from an engraved reproduction of Von Humboldt's sketch, and probably no other picture of geographical scenery has ever had a wider circulation. The cut in question gives Cotopaxi the outline of an isosceles triangle, the slopes having an angle of about sixty degrees. A photograph recently taken shows the slope of the flank to be less than twenty degrees. The general appearance of the mountain as photographed, however, bears much resemblance to the earlier reproductions of Von Humboldt's sketch.

The profile views which usually accompany geographical textbooks are also open to a certain amount of criticism on this score. That vertical exaggeration is necessary to the usefulness of a profile, no one will deny; but to make the vertical scale five hundred times the horizontal scale, as is occasionally done, is an unpardonable license. Because of the exceedingly limited horizon of an observer, there is a seeming vertical exaggeration of the heights of mountains as they appear to us in nature. This illusion becomes less as the horizon enlarges, and could we view a part of the earth's surface at an altitude of one hundred miles, the outlook would be vastly different from our present concepts. As a result, we are apt to exaggerate vertical distances from five to fifteen times their actual proportions in order to have them appear what they seem to us actually to be. This is probably the reason why all expert topographical modellers insist on a certain amount of license in this particular, and they know too well that their work would be condemned *in toto* were very large areas represented on exact scale.

Plains.— A definition of '*plain*' is also wanting, and the term is used indiscriminately to denote highland plains, lowland plains, and rolling lands. Common sense would suggest that the word should be applied to moderately level lands, and there is no impropriety in designating them as highlands or lowlands, as the case may be. For rolling or undulating surfaces, which are too rough to be called plains, the term *piedmont* lands is coming into gen-

eral use among geographers. Thus the rolling surface between the Atlantic Plain and the foot-hills of the Appalachian Mountains are *piedmont* lands, and the same distinction will apply to the country surrounding the Ozark Mountains.

Erosion.— No other term employed in describing the weathering processes of nature is more generally misused than '*erosion*,' a term which is used to cover every kind of degradation or wearing. We are largely indebted to our geological survey for the various terms used in describing the wearing away of the land-surface, and these are so simple that there is no need of the confusion and misuse which now exists. The following extract from a paper read before the National Academy of Sciences by Professor Powell, Director of the United States Geological Survey, shows plainly the proper use of the words: —

"In hydraulic degradation three methods may be distinguished. 1. The surface of the land is washed away by rains and melting snows. The rains gather into streams, as brooks, creeks, and rivers, and transport the disintegrated rock from one region to another. This general surface degradation may be called '*erosion*.' 2. During the process of transportation the streams carve channels for themselves, and this channel-cutting may be called '*corrasion*.' 3. By erosion and corrasion cliffs are produced, and these cliffs (once undermined) are broken down by gravity. This method of degradation is called '*sapping*.'"

Volcanoes.— The ordinary idea of the volcano is also wide of the truth. A volcano is nearly always defined as a *mountain* which sends forth *flames, smoke, ashes*, and melted rock *from an opening called the crater*. Now the volcano is not a mountain, but a hole. More specifically, it is a channel leading to a reservoir of intensely heated matter deep in the earth. There are no visible *flames*, and, indeed, it is extremely doubtful whether there are any flames at all.[1] For, excepting the exceeding small amount of hydrogen that is sometimes present among the products of eruption, there

[1] In one or two instances pale lambent flames were observed by Touquè. These were due to the oxidation of gases at the close of the eruption.

is nothing combustible. The lurid glare, which gives the appearance of flames, is due to the white-hot vapors, and to the reflection of the molten lava or the clouds of steam or vapor that issue from the crater. The *smoke* of the volcano consists of dense clouds of condensing steam and other vapors. The *ashes* are not ashes at all in the ordinary meaning of the word. They consist mainly of finely pulverized mineral matter, totally unlike the residue left from the burning of wood or coal. The crater is not the *opening*, but the cup-shaped depression at the top of the volcanic mountain.

The 'mountain' is no part of the volcano; it consists merely of the *ejecta* which have been heaped about it. In many instances there is no mountain, and the floor of the crater is not more than a few hundred feet above the plain. Sometimes the volcano is below the surface of the sea, and the materials ejected are piled about the opening until they reach to the surface of the water. In some instances the crater of the volcano is a deep pit or 'caldera' situated at the top of a plateau, every appearance of a typical mountain-peak being absent. A notable instance of the last is seen in the volcanoes of Hawaii. The island of Hawaii is about the size of the state of Connecticut, and its surface rises gradually from the sea-level until in the interior it is about 14,000 feet high. Kilauea, Mauna Kea, and Mo-kea-weo-weo (incorrectly called Mauna Loa) are deep calderas on the flanks of the plateau at a high elevation.

As usually given the descriptions of the phenomena of an eruption are incomplete. The popular idea is that the eruption consists of a terrific outburst, and a violent upheaval, accompanied with the ejection of huge rocks and vast quantities of lava, high into the air. That such eruptions occur it is true, but they are the exception rather than the rule. The eruptions of Vesuvius are of this character, and because this volcano is so well known, it is nearly always taken as an illustration of the typical volcano.

Briefly stated, eruptions of the Vesuvian type consist first of an explosion in which the floor of the crater, or perhaps the whole

top of the mountain, is blown away. Accompanying the explosion dense clouds of steam, with sulphureous and other vapors are ejected to a great height. The flow of lava then begins, and the stream of molten matter flows over the edge of the crater, or perhaps is forced into a multitude of channels through the side of the mountain. The lava is expelled by the expansive force of the gases back of it, and when the reservoir of lava is exhausted, these gases escape, carrying with them a vast shower of 'ashes' which are borne by the winds hundreds or even a thousand miles away.

In some instances the lava rises silently and without apparent violence until it fills the crater and flows over the side. The eruptions of the Hawaiian volcanoes are of this character. It is hardly necessary to add that earth-shocks and showers of 'ashes' do not accompany such eruptions.

Perhaps the most interesting volcano to the student of vulcanology is Stromboli, one of the Mediterranean group. This volcano has been in a condition of semi-activity for several hundred years. Its 'eruptions' consist merely of a rather brisk ebullition of the lava in the crater, and the escape of pent-up gases which are probably formed by the chemical changes going on within the mass of the lava. One side of the ramparts of the crater has been considerably broken down, while the opposite side, several hundred feet higher, projects slightly over the caldera. From the summit of this crag one may safely view the seething lava below. As one watches the surging mass of molten matter, an immense bubble of gas pushes itself up to the surface, and bursting, throws a shower of fiery clots of lava a thousand feet or more into the air.

Perhaps there is no phenomenon so frequently misinterpreted as that of the eruption of volcanoes. Almost yearly we are informed of the eruption of some volcano or other which has been quiet for years. Thus the outburst which occurred in the Colorado Desert some years since was nothing more nor less than the formation of a hot mud-spring. It is more than probable that a hot spring had always occupied this site, but at the time of its free advertising as a volcano, its flow had enormously increased, owing

to a recent earthquake. The author visited the locality twice, the second time after an interval of two years, but there were no other volcanic phenomena apparent.

The alleged eruption of Tacoma, or Mount Rainier, Washington, consisted of nothing more serious than a fire in the fir timber which so profusely covers the flanks of the mountain. The smoke which is asserted to come from the crater of Mount Hood,[1] Oregon, is merely a cloud banner formed from the vapor condensed by the snowy crest of the mountain.

A still more misleading case was the alleged eruption near Babispe, a small adobe town in Mexico. As described in a New York journal, the eruption was attended with severe earthquakes, while the lava set fire to everything in its path. Now, here was a clear misconception from beginning to end. The facts occurred nearly as stated, but the interpretation was all wrong. What really occurred was a series of very severe earthquakes, and an immense fissure and fault in the strata now marks the site of the shocks. The town of Babispe was destroyed by fire, it is true, but it was first shaken to pieces and then burned in the ordinary manner. There was no flow of lava, although there was a flood of hot, muddy water which was probably squeezed out of some underground reservoir or other. The 'fiery crest of the mountain' certainly 'reflected a lurid glare' for miles around, but the glare came from the forest fires which swept through the mountains during the few days following the earth-shocks, and not from any outflow of lava.

The existence of volcanoes in Central Asia, near the head-waters of the Irtish River, rests on very slim authority. That hot mineral springs exist there is more than probable, but of the existence of a true volcano there is absolutely no authoritative evidence whatever.

Depressions in the Land below the Sea-Level. — The extent of land whose surface is below the sea-level is greater than

[1] I have frequently observed the cloud banner flaunting from Mount Hood, as well as from various peaks in the Alps. They are identical with those described by Professor Tyndall in 'Forms of Water.' — J. W. R.

commonly supposed. The depressions are, with one or two exceptions, rather small in size, and lie mainly in a belt between the 30th and 40th parallels of latitude. A peculiar feature of these depressions is their proximity to the seacoast. In nearly every instance they are within 200 miles of the ocean. The following list embraces the more important ones: —

The Ghor is perhaps the most notable of all depressions. It lies about fifty miles east of the shores of the Mediterranean Sea, and embraces the greater part of the valley of the Jordan River, including the Lake of Tiberias (Sea of Galilee), and the Dead Sea. The former lake is about 670, the latter 1302, feet below the sea-level.

The Shotte includes several depressions in Africa, lying in a line south of the Atlas Mountains. They seem formerly to have opened into the Gulf of Cabes. According to Dubocq (*Mémoire sur le Ziban et l'Oued R'ir*) the Shotte are situated at levels varying from 95 to 279 feet below the sea, and covering about 1000 square miles.

On the authority of several recent writers there is a large depression in Sahara, south of the peninsula of Barca, which, it is asserted, covers an area of more than 100,000 square miles. Careful investigations do not support this belief. On the contray, Andrees' map (edition of 1886) contains over 100 established levels, made by Rolfe in 1874, scattered over the region in question. Of these two only show a depression below the sea-level, — one of 90, the other of 210 feet. The other levels show an average altitude of not far from 1000 feet above the sea-level.

The Sea of Assal is a small depression in Africa, probably shut off from the Gulf of Aden. Its surface is about 570 feet below the sea-level.

The Caspian Sea partly fills the largest known depression on the earth's surface. This depression includes the lower courses of the Volga and Ural rivers, and has an area estimated at 200,000 square miles, of which the Caspian Sea covers about 140,000. The basin is dotted with a multitude of small playa

lakes, of which Lake Elton is the largest. The surface of the Caspian Sea is 84 feet below the sea-level.

The Arroya del Muerto, or Death Valley, and the *Sink of the San Felipe*, both in the southern part of California, are the only depressions at present known in the Western Continent. At King's Springs, Death Valley is 225 feet below the level of the ocean, but there are one or two other points in the valley somewhat lower. The Sink of the San Felipe, or Conchilla Valley, is a much larger depression, extending over an area about one hundred miles long and thirty in width. It is probably a continuation of Death Valley. The Southern Pacific Railway now crosses this depression 261 feet below the sea-level. The author crossed it in 1877 at a point where an aneroid barometer showed an altitude of 320 feet below the sea. It is probable that the deepest point in this depression is not far from 400 feet below mean tide. It is only a few miles from this locality that the celebrated 'Ship of the Desert' was found. This famous vessel, which has been made the subject of a popular poem, is beyond doubt the frame of a ferry-boat designed for the Colorado River. The builder attempted to drag the frame to the river, but his teams died in the desert and the boat was abandoned. The projector of the enterprise was living in 1885.

There has for some years been an impression that a low neck of land in the northern part of the peninsula of Lower California is covered by the sea at times of unusually high tide. This belief is absolutely without foundation. The lowest crest of the northern part of the peninsula is between the sources of the Rio de las Palmas, which flows into the Pacific, and a dry wash leading to the Sink of the San Felipe. This crest is not less than 1000 feet in height, and probably somewhat higher. It is hardly necessary to add that the water does not cover it at high tide.

The Character of Deserts. — There is a general opinion concerning the character of deserts which is a misinterpretation of the facts of the case. It is the common impression that the soil of the desert is covered with sand, and that its surface is low

and level. Now, if there is anything that is scarce in most desert regions, it is sand; water is abundant in comparison. The soil of the desert may be of any character. What is usually spoken of as sand is, in nearly every instance, finely pulverized soil containing not a grain of sand. In a certain part of the Great African Desert there is a locality in which true sand is abundant. In this case, however, the sand is derived from high ranges of sandstone rock. This desert is a desert for lack of water, and not because of the presence of sand. The soil varies in different localities, and consists in different places of sand, gravelly shingle, alkaline dust, yellow loam, clay, or rock. The surface, which in some places is smooth and level, in others is rugged and mountainous. East of the centre is the lofty range known as the Tarso, or Jebbel Hoggar Mountains, snow-clad during one-third of the year. In the Colorado and Mojave deserts of California, the soil is almost exclusively a finely pulverized feldspar, derived from the disintegrated granite of the mountain ranges which traverse the region.

It is a mistake to consider the soil of a desert sterile. On the contrary, it is usually rich, because none of its essential elements have been removed by growing vegetation. Wherever water can be obtained vegetation quickly becomes luxuriant. It would be difficult to find more productive spots than Humboldt, Nevada, and Dos Palmas, California; and yet a few years ago the sites on which these places have been built were so parched and dry that even sage-brush and cactus would not thrive there.

Coral Islands. — The idea of the coral island commonly expresses itself in a picture of an atoll. In nearly every instance the picture shows a circular ring without a break, encircling an empty lagoon. That coral atolls have in some instances a circular, ring-shaped form cannot be denied; but in most instances the shape of the ring is anything but circular. It is always more or less irregular, and, in many cases, very angular. Sometimes the atoll consists of a great number of small islets arranged in ring form; sometimes it is only a fragmentary part of a ring.

The nomenclature of coral islands is frequently confused; the words atoll, barrier reef, and fringing, or encircling reef, being indiscriminately used. One of the best authorities on the subject uses the term *atoll*, a Malay word, to designate the ring-shaped islands; *encircling* or *fringing reefs*, to denote those very near the shore; and *barrier reefs*, to describe those that are at a considerable distance from the shore, and separated from it by a wide lagoon. It is doubtful if this nomenclature can be improved.

The most prevalent idea of the origin of the coral reef is the theory proposed by Darwin. According to his idea, the coral polyp built a fringing reef about a volcanic or other elevation. The latter, sinking slowly, compelled the coral polyp to build higher, in order to keep near the surface. That such a theory accounts for many of the various phenomena of coral islands cannot be denied; but it is equally true that it will not apply to all coral formations, for in some instances coral reefs rise to a height of several hundred feet. Such cases can be explained only by admitting that in these particular localities the movement of the land has been one of elevation rather than depression. Such examples may be seen in the Loyalty Islands. On approaching them the cliffs have much the same appearance as the high chalk cliffs of England, except that they are some distance inland, instead of rising immediately from the sea. On the island of Marè lines of cliffs rise successively inland, forming a series of terraces. Now each of these terraces indicates a distinct upheaval, and the periods of rest between upheavals have been of sufficient length to permit the formation and accumulation of soil to the depth of several feet.

The investigations of Agassiz, Semper, Murray, and others have brought to light many facts which show that the growth of reefs and atolls can be accounted for without the supposition of a subsidence of the sea-bottom. In the waters of tropical latitudes marine life of almost every kind exists in the greatest profusion, and skeletons of such organisms accumulate at the bottom. The magnitude of these accumulations may be seen in the chalk cliffs

of Western Europe and the infusorial deposits of California.[1] The continued increase of such deposits would, in the course of time, raise the tops of submarine mountain-peaks and plateaus to the limit within which the coral polyp can exist.

The question is occasionally propounded, 'Whence comes the fresh-water supply of coral, and low, sandy islands?' The supposition is sometimes explained by asserting that the islands are supplied with the fresh waters of submarine springs. Now such a supposition is simply absurd on the face of it. That a stream of fresh water should burrow its way under the ocean several thousand miles, and rising, hit an island, is a hypothesis which will not stand examination. Such islands receive their water supply in the same manner as does any other part of the earth. The rain falls, and the water that does not flow off or evaporate, sinks into the ground, and may be found by digging for it. In the former case, the rain-water rests on a bed of clay, or other impervious earth, through which it cannot pass; in the latter, it rests on a bed of salt water, with which it does not mix because it is lighter.

Variation of the Compass. — Frequently we are told — 'The needle of the compass points north and south.' Occasionally the statement is modified to read 'nearly north and south,' but this is the exception rather than the rule. As a matter of fact, there are but few localities on the earth where the needle of the compass does point due north and south, and these are constantly changing. An irregular line drawn from the mouth of the Orinoco River, through the east coast of Hayti, Charleston, S.C., and Detroit, Mich., represents very nearly the line in which there is no variation at the present time. In all places east of this line the *north* or — end of the needle swings slightly to the westward; in all places west of it, to the eastward. At the mouth of the Columbia River the variation of the compass is about 22° E.; in Alaska, it is from 40° to 60° E.

[1] These infusorial deposits in Los Angeles County have an aggregate thickness of several thousand feet.

The reason for this is that the compass needle points, not to the geographical, but to the magnetic poles, and these do not coincide with the geographical poles. The magnetic north pole is at present on or near the southwestern shore of Boothia Peninsula, in the northern part of North America. Its position is constantly changing, and it is thought that, during the last six hundred years, the magnetic pole has moved about half the distance around the geographical pole. During a period of three hundred years in which observations have been carefully made at the magnetic observatory in Paris, the variations have changed from 11° 20′ east of north to 22° 10′ west. In the United States the rate of the change in variation differs much in different parts of the country. In Washington and Oregon it changes at the rate of about 7′ a year; in Arizona and New Mexico it is stationary; in the New England States it is from 1′ to 3′ per year.

The 'dip' of the compass needle is rarely spoken of in geographical text-books, and it is generally inferred that the horizontal attraction is the only feature of magnetic force. The dip of the needle is, in polar latitudes, a much stronger force than that of the orientation, or north-and-south motion of the needle. In equatorial latitudes the dip is not noticeable, but as the observer approaches polar latitudes, it becomes stronger, until at the magnetic pole the horizontal force disappears and the needle assumes a vertical position, the — end being next the earth at the north magnetic pole, and the + end at the south magnetic pole.

Often in whaling vessels or other ships which cruise in high latitudes one may notice a string reaching from the binnacle to the wheelsman, who occasionally gives the compass box a sharp jerk. This he does in the hope that the needle will settle down to a fixed direction. It may be inferred from this that the horizontal force is so weak that the compass is not of much use in polar latitudes, — a conclusion which is correct.

VIII.

HYDROGRAPHY.

Deep-Sea Soundings. — Modern methods of deep-sea sounding have not only yielded extremely interesting results, but they have also shown that the deep soundings formerly made with the cumbersome manilla rope are wholly untrustworthy and enormously exaggerated. Lieutenant Berryman, of the United States brig *Dolphin*, found no bottom in the Atlantic at 6500 fathoms. Captain Denham, of the British steamer *Herald*, reported bottom in the South Atlantic at a depth of 7700 fathoms. Lieutenant Parker, United States frigate *Congress*, near the same place, ran out 50,000 feet of line without finding bottom, — all this in the face of the fact that more modern soundings have shown no great depth of water in the same localities.

In 1872 Sir William Thomson brought steel piano wire into successful use for the purposes of sounding.[1] The wire employed is $\frac{8}{100}$ of an inch in diameter and will stand a strain of 230 pounds. The manner of its use has been greatly improved in turn by Commander Belknap, United States Navy, and Lieutenant Sigsbee of the Coast Survey steamer *Blake*. By the improved method the sounding-wire carries a fifty-pound sinker, a Miller-Caselli thermometer, and an automatically closing tube which receives a specimen of the ooze at the bottom of the sea. When the sinker strikes bottom,[2] it detaches itself and, at the same time, closes the tube or cup which secures the specimen of sea-bottom.

[1] Steel wire was first used in deep-sea sounding in 1852.

[2] On account of the enormous pressure at these great depths — between 80,000 and 100,000 pounds per square inch — there is a general belief that the sinker will float at a certain depth, on account of the density of the water. Not only is this untrue, but a sinker attached to a light wire will drop about as rapidly between 4000 and 5000 fathoms as between 1 and 4000.

The deepest sounding yet recorded in any part of the ocean was made by the United States steamer *Tuscarora*, in the Pacific Ocean, a few leagues off the Kooril Islands, where a depth of 4655 fathoms (27,930 feet) was reached. In the Caroline Archipelago the *Challenger* found a depression in which a sounding of 4475 fathoms was obtained. Between the Sandwich Islands and the island of Hondo, the *Tuscarora* found a group of six submerged mountains varying from 7000 to 12,000 feet in altitude, their crests being at least 1500 fathoms under water. Their sides and summits were found to be clothed with coral limestone, while lava and a yellowish-brown soil were discovered in the valleys. The deepest part of the Atlantic Ocean yet discovered lies about seventy miles north of Porto Rico. Here Commander Brownson of the *Blake* obtained soundings of 4561 fathoms (Jan. 27, 1883), and Commander Barker of the United States steamer *Enterprise*, a depth of 4529 fathoms (February, 1886).

Modern soundings have shown that the bed of the sea is far more level than the surface of the land, except in the vicinity of the continents, and the coral islands of the Pacific. Between New York and Liverpool there is no known grade too steep for a railway train to climb with ease. From an average of several thousand soundings it is estimated that the wider parts of the ocean have a depth varying in general from 2000 to 3000 fathoms. This estimate agrees fairly with the theoretical depth calculated by Professor Bache of the United States Coast Survey.

The Ocean Current as a Factor in Climate. — The relation of warm ocean currents to the climate of the country against whose shores they drift is not generally interpreted with accuracy. The idea, not infrequently imparted, that the mere impinging of warm water against the shore is sufficient to modify the temperature of a region, needs only a second thought to show its fallacy. Within the past few years the facts have been more correctly stated, by asserting that the water warms the winds, and the latter in turn impart warmth to the region over which they blow; this, however, tates only part of the truth.

Let us look at the facts of the case. When warm winds blow over a drift of water, a great amount of moisture is evaporated. When these winds reach cooler regions, a part of their moisture is condensed in the form of rain. The condensation of the moisture sets free an enormous amount of the latent heat which was absorbed when the water took the form of vapor. When we consider that the condensation of one pound of vapor sets free enough heat to warm 967 pounds of water one degree, we may better understand the value of such a factor, and its potency in tempering climate. In fact, it is a bodily transfer of heat rather than an ordinary warming process.

That the ocean current has a decided influence on the condition of the coast, however, cannot be doubted. A coast in high latitude, constantly swathed by the waters of a cold current, is pretty apt to be ice-locked during much of the year, for the reason that, constantly surrounded by cold water, the winter's accumulation of ice has but little opportunity to melt. On the contrary, a coast bathed by warm water will loosen and melt the ice about as fast as it forms. Yet, in spite of this diversity of condition, the average winter temperature of the two places may not differ more than a few degrees.

This leads to the discussion of the common assertion that if the Panama Canal were once cut through the isthmus, the whole coast of Europe would suffer a great decrease of temperature. Such nonsense as this has found its way into even the more respectable educational journals. Let us examine the facts of the case. The great equatorial current, in its westward course, must necessarily divide off the coast of South America. One half, we will say, is diverted southward; the other half northward. The current in question is not far from one thousand miles in width, and it is quite reasonable to suppose that its depth is two hundred fathoms at the very least. Now in order that no part of this current be swirled off in the form of a circular return current, the canal through the Isthmus of Panama must be at least one thousand miles wide and twelve hundred feet deep. A canal of this

size might possibly affect the climate of Europe very slightly, though, as is seen in the foregoing paragraphs, the effect will not be great. But the proposed Panama Canal is a ditch which at the best would carry a stream less than one hundred feet wide and fifty feet deep. Even were the Gulf Stream turned directly against this canal, it would have no effect on the climate of Europe. A stream of hot water poured out of a tea-kettle would be equally potent in modifying the climate of Labrador.

The Gulf Stream. — It is now more than ten years since Commander Bartlett, U.S.N., published the result of his surveys in the Gulf Stream. The amended chart of this stream has appeared in one or two recent text-books, but the essential features of Bartlett's surveys are rarely comprehended. *The Gulf Stream does not make the circuit of the Gulf of Mexico, and then pass outward along the Florida coast.* On the contrary, little or none of the water of this stream enters the Gulf of Mexico. The Gulf Stream, after leaving the Carribbean Sea, passes directly through Florida Strait, and it is at this point that the current really originates. From Florida Strait to Jupiter Inlet the current has a velocity varying from four to five and a half miles an hour. Beyond the 50th parallel it gradually spreads out in a fan-shaped drift, which is pushed northeast and east until it becomes a mass of water subject to the caprice of the winds only.

The Gulf Stream is not a 'river whose bed and banks are the cooler waters of the ocean.' On the contrary, in most of its course it extends to the bottom, and even at the bottom its current is so strong that it sweeps the minute shells with which the Caribbean Sea is covered, as far north as Cape Hatteras.

It is surmised that a part of the Gulf Stream flows northward as an undercurrent, after passing the 50th parallel. This is almost wholly a matter of opinion, and in the present state of deep-sea soundings there is not sufficient evidence to fully establish such a theory. The strongest confirmation comes from Nordenskjöld, the famous Arctic explorer. During Nordenskjöld's explorations along the east coast of Greenland a number of soundings were made

with reference to temperature. A few leagues off shore a stratum of comparatively warm water was observed at a depth of fifty fathoms. In a few instances the temperature of this water was from twenty to thirty degrees warmer than that of the surface. It is at least reasonable to suppose that this stratum consisted of Gulf Stream water, but it is by no means an established fact.

Off the coast of North Carolina an adverse current is frequently encountered which has been a puzzle in ocean hydrography. This current pushes in a general southerly direction, even in the face of a strong wind. Because of its turbulent, choppy character it is not a favorite among navigators, who have given it the expressive but inelegant name, 'Little Hell,' by which it is known on the pilot charts. It has been surmised that this current is caused by the rising of the Arctic current.

The Kuro Siwo. — For many years it has been regarded as an accepted fact that the part of the Kuro Siwo (*koo'ro she'vo*) entered the Arctic Ocean through Bering Strait. In order to study the currents of Bering Sea and Strait, Dall and Baker, of the United States Coast Survey, carried on a series of observations covering a period of three years. The result showed not only that no part of the Kuro Siwo enters Bering Strait, but that actually a feeble current emerges from it. The surveys of this stream show that it is a smaller, and also a colder current than the Gulf Stream. Its waters rarely exceed 68° in temperature, while those of the Gulf Stream sometimes reach 86°. In winter, when the northwestern monsoons prevail, the Kuro Siwo does not flow beyond the 30th parallel, and sometimes its progress is checked for several days by adverse winds. During the summer, however, when the southeastern monsoon blows with full strength, this current is pushed northward as far as the Kooril Islands. The drift of the Kuro Siwo bears the same relation to the western shores of North America as that of the Gulf Stream does to Western Europe.

Direction of the Tide-Wave. — Another common error is entertained with regard to the direction of the tide-wave. We are usually taught that the tide-wave moves from west to east. That

is certainly its *general* direction. But the law is observed only in the broad expanse of the southern oceans: north of the equator the rule becomes rather the exception. In the North Atlantic the wave moves northward, and bending around the north coast of Norway, turns eastward, and is finally lost in the Arctic Ocean.

Brainard, one of the survivors of the Greely Expedition, made a number of interesting discoveries about the direction of the tide-wave. At Lady Franklin Bay, the northern station, the tide came in from the *north*. Here the incoming tide was about two degrees warmer than the outgoing tide. At Cape Sabine, the southern camp, the tide came from the *south*. This remarkable phenomenon General Greely interprets as establishing the insular character of Greenland. In his opinion it can be accounted for only by the supposition that the water flows around the northern shore of Greenland, and, entering Robson Channel, flows southward to Hall Basin.

The Tidal Wave. — The so-called tidal waves, following earthquakes which originate near the sea, should not be confounded with the daily tide-waves. So far as origin is concerned they have nothing whatever in common. The former are probably caused by the oscillation, or up-and-down motion, of the earth's surface which takes place when an earthquake occurs under the sea. The tidal wave following the earthquake at Arica, a few years since, was a fine example of waves of this character. Shortly after the first shock the water receded from the anchorage, leaving the latter bare. In a few moments, however, an enormous wave estimated to be thirty or forty feet high came rolling in. The fleet which the receding water had left stranded, was picked up and the vessels tossed about like egg-shells. The smaller craft were at once broken to pieces, and sunk. An English man-of-war held to her anchors until the wave began to fall back, but with the outflow of water, snapped her cables, and was carried seaward. Another incoming wave caught her astern and sent her to the bottom. The United States steamship *Wateree* escaped more easily. This vessel was carried along on the crest of the wave, and gently

stranded on the sand, several miles inland. The use of the word 'tidal wave' to describe such waves as are caused by earthquakes is unfortunate and inaccurate.

Occurrence of the Tide. — As a general thing, we are left to infer that there are but two tide-waves a day. This is strictly true when the sun and moon are in conjunction, but not at other times. When the sun and moon are in opposition, there are four tide-waves, — two of the sun and two of the moon. The former are very slight and scarcely noticeable except by delicate measurement. As the moon swings around into conjunction, the solar and lunar waves again blend into one. It is true that the solar wave may be practically neglected because of its insignificant size, but the principle holds true, and as a matter of consistency it should not be neglected when the subject of tides is discussed.

It is well to impress the fact that the *daily* occurrence of the tides is due, not to the revolution of the moon, but to the daily rotation of the earth. If there were no axial rotation of the earth, there would be practically but two tides a month. The waves revolve around the earth just as though they were fastened to the moon, but the diurnal feature of the tide is the result of the earth's turning on its axis within the tide-waves.

In describing the abnormally high tides which are found in nearly all V-shaped estuaries which face the tide-wave, we almost always fall back on the Bay of Fundy as an example. As a matter of fact, the tides of this bay are high, but there are fifty places along the coast of Maine where tide-water is nearly as high as in the bay named. The extreme high tide is not found in the Bay of Fundy, but in Minas (or Mines) Basin, a long, narrow estuary which is an arm of the Bay of Fundy. Here the tide rises occasionally to a height of eighty feet.

The famous Maelstrom off the coast of Norway is quite as interesting an object as the mythical Lurlei, but, unlike the latter, the myths of the Maelstrom are too often recounted as geographical facts. That our accounts of this local current are drawn mainly from the myths of the dark ages is hardly necessary to say. As

a matter of fact, it is by no means so dangerous to navigation as the Hellgate (formerly Horllgatt, *i.e.*, whirling strait) in East River, which it somewhat resembles. The Maelstrom is a tidal current formed by the peculiar shape of the small chain of rocks belonging to the Loffoden Islands. Two of the islands of the chain form a hook-shaped curve which faces the flowing tide. As the tide rushes into the constricted passage, the circular shape of the basin gives the water a choppy, and at the same time a slight vorticose motion. At all seasons the water is more or less turbulent at the change of the tide, but at times of excessive tides the Maelstrom becomes a very rough and a dangerous place to small craft. With a strong northwest wind it becomes still more perilous. The water is lashed into scud, and the swirling currents are too powerful for any but the stoutest of vessels. The traditional 'howling of demons,' like the song of the Lurlei, of course refer to the sounds produced by the winds and the noise of the swirling water.

The Sargasso Seas. — The great accumulations of marine plants commonly known as the Sargasso Seas have long held a position of importance in school-book literature to which they are hardly entitled. In general, they are asserted to originate in the vast swirls of the ocean currents north and south of the equator, in both the Atlantic and the Pacific Ocean. These enormous eddies, it is asserted, by their vorticose motion, carry masses of seaweed to their respective centres, making what the early Spanish sailors called Zargazzo or Grassy Seas.

That there are great accumulations of marine plants in the regions indicated is certain, but that they are due to the vorticose movement of ocean currents is by no means an established fact. Marine plants thrive only in moderately warm, still waters. They are therefore most abundant in the regions of calms, and in sheltered parts of the ocean. The writer has several times crossed the Sargasso Sea southeast of the United States, and in every instance vast though not unusually large masses of seaweed were in sight. An inspection of a good physical map of the ocean will show that

the Sargasso Seas correspond with the calms of the tropics, and there is strong evidence that they move north and south along with the calms.

Thick accumulations of marine plants are common on the Pacific coast of the Western Continent, along all leeward coasts, and in channels bathed by warm waters. Indeed, it would be difficult to find denser mats of seaweed than those which occur in San Pedro Bay and Santa Barbara Channel during the summer months. The same is also the case with the leeward shores of nearly all tropical and sub-tropical regions. Now, although it is not impossible that the vorticose movement of ocean currents may be a factor in the accumulation of marine plants in the localities known as the Sargasso Seas, yet it seems more reasonable to hold that comparatively still waters and high temperature, and not the vorticose motion of ocean currents, are the chief causes.

Lakes. — Another common assertion having a place in geographical literature is, that 'lakes which have no outlets are salt.' Now, it is reasonably correct to assert that salt lakes have no outlets; but to reverse the statement is most certainly untrue. A large majority of those lakes which have no outlets are fresh. Whether or not a lake without an outlet is salt, depends almost entirely on the character of the soil over which its feeders flow. If a lake occurs in a region where the soil contains little or no sodium, potassium, or magnesium salts, its waters will not become saline, simply because there are no soluble salts in the soil. There are thousands of such lakes and ponds in the upper basin of the Mississippi River. In some of them the water is 'hard,' because of the amount of limestone which is characteristic of this valley; but scarcely one is salt.

On the other hand, if the depression in which the lake is situated is in the midst of an alkaline formation, its waters are pretty apt to be impregnated with mineral salts, or else they will become so in time. Great Salt Lake, in Utah, is salt because the soil of its basin is highly impregnated with chlorides and sulphates of the alkaline metals. Lake Tchad, in Africa, is fresh because its basin

contains a soil which is either free from mineral salts, or else protected by a layer of alluvium, which prevents a solution of the salts. Occasionally, in very wet years, Lake Tchad overflows its basin-rim, and the waters are lost in the desert to the northeast. But the overflow has little effect on the quality of the water so far as its saltness is concerned, for the lake is at such seasons an immense tule-swamp covering an area of nearly 50,000 square miles. The secret of its freshness is that all its feeders flow through an alluvial soil which contains little or no soluble mineral matter.

In the Great Basin of Nevada, Utah, and California we find a still more perplexing problem. Here are several lakes — Pyramid Lake, and Humboldt and Carson Sink — whose waters may be called fresh, while these of Mono, Owens, and Great Salt lakes are loaded with saline matter. A careful study of this lake region has led to the discovery that it is subject to alternate periods of excess and of deficiency of rainfall. It is not known when each period occurs, but that there are such periods is certain. At a no greatly distant time in the past this basin was covered with two large inland seas, each considerably more than half the size of Lake Superior. Several of the old shore lines, which marked the periods of maximum height of water, are still visible along the slopes of their basins.[1] When the period of drought came, many of these lakes dried up; *others did not.* Great Salt Lake and Owens Lake did not, and their waters are to-day exceedingly briny. The waters of Pyramid Lake and Humboldt Sink disappeared, leaving a thick crust of crystalline salts in their beds. But this mat of saline matter was quickly covered with the dust and detritus with which the Washoe 'zephyrs' darken the air. So when the dry lake beds began to fill again, their basins were practically free from saline matter, and thus these lakes are to-day practically fresh.

[1] It is a singular and noteworthy fact, that the shore lines on certain islands in the middle of these lakes are considerably higher than the contemporary marginal shore lines.

In our text-books we sometimes make four classes of lakes, viz.: —

Those having inlets, but no outlets.

Those having outlets, but no inlets.

Those having both inlets and outlets.

Those having neither inlets nor outlets.

Such a classification is the acme of nonsense; it has nothing whatever to recommend it. A better way is to classify them as those which have outlets and those which have none. A more sensible way than either, is to divide them into fresh lakes and salt lakes. Still another classification is frequently used by the geographer, — glacial lakes and playa, or steppe lakes. The former includes such lakes as have been shaped by the action of ice and running water; the latter, the shallow pools, swamps, and marshes which are frequently found in plains.

The primary idea to be kept in mind concerning the lake is, that it is a depression. If more water flows into the hollow than evaporates from it, a lake is formed; otherwise there is no permanent body of water. As the water collects, the basin continues to fill, either until the evaporation just balances the supply, or until it overflows at the lowest part of the rim.

Lakes of glacial origin may usually be distinguished by their shape and the direction of their lines of greatest length. An inspection of a well-drawn drainage map shows that such lakes are long and comparatively narrow. Their lines of greatest length are nearly parallel, or possibly radial. A good map of the State of New York, the New England States, and still better, of Sweden, will teach a most interesting lesson.

It is quite common to read the assertion that the Caspian and Aral seas are below the level of the ocean. This is certainly true of the Caspian, but equally untrue of the Aral Sea. The former is eighty-four feet below the level of the ocean; the latter about fifty feet above it. There is some little evidence to show that the two seas were formerly connected, and a chain of shallow pools stretches between the two lakes. In the case of the Black and the Caspian

Sea the evidence is much stronger, for the old silted channel may be traced nearly the whole distance. Many geologists believe that the Caspian Sea once reached much farther north than at present, and opened into the White Sea. This theory is by no means improbable, and a contour map of the region in question is an exceedingly interesting study, with this theory in view. It is well to bear in mind that this is as yet a matter of theory.

Another commonly misapplied term is the 'lagoon.' We frequently use this word as the synonyme of 'lake,' but this is not its proper use in modern geography. The lagoon is essentially that part of the sea or other body of water which has been nearly enclosed by wave-formed islands. Along the eastern coast of the United States we find lagoons wherever the coast is low and level. Albemarle Sound and Pamplico Sound are fine examples, and there are many others equally striking along the Gulf coast. The lagoon and sand-spit are interesting studies in physical geography, because they show how additions to the area of a low coast plain are commonly made. The rivers deposit their loads of silt into the sea just off shore. The combined action of waves and currents pile it up in the long, narrow spits, which enclose the lagoon. In time the lagoon fills up and becomes covered with verdure, and then the process is again repeated a little farther seaward.

Rivers. — The increase in the width of a river or other stream of water in its downward course and the alleged cause therefor, are so well known that the question of its accuracy is rarely challenged. Perhaps ninety-nine in one hundred, if asked the cause of the increase in volume, would unhesitatingly reply that it was due solely to the uniting of smaller streams and tributaries with the main river. That this is true so far as it goes cannot be denied, but the explanation does not go far enough. In the upper courses of rivers the chief increase in volume is due quite as much to the seapage from the bed and banks of the river as to the inflowing of tributaries. That the seapage is enormous, every miner who has 'prospected' along a mountain torrent can testify,

for a prospect hole fills with water just as quickly as a newly sunk well does. The great increase in volume may be readily observed wherever a railway winds along a river cañon. In crossing the Wasatch Mountains on the Denver and Rio Grande Railway the train crawls slowly up the grade from the mouth of Spanish Fork to Soldier Summit. The distance is scarcely more than twenty-five miles, yet Spanish Fork near the summit of the divide is a stream not more than a foot wide, while at the mouth of the cañon it is more than a rod in width. Yet from summit to base it does not receive a single tributary. Its entire increase is due to the seapage from the rocks and soil through which its course lies. The same description applies equally to Price River, whose source is a few rods from that of Spanish Fork, on the opposite side of the divide. Similar examples are by no means rare; they can be observed in almost every locality, if one will only look for them.

On our maps it is customary to chart a river with a fine line at the source, widening the line towards the mouth. This is in the main correct, but it has perhaps given rise to the idea that a river constantly increases in width from source to mouth — a conclusion by no means true. In the majority of instances a river has its greatest width along its middle course. The Mississippi, for instance, eighteen hundred miles from its mouth, has an average width of about 5400 feet, while at New Orleans, near its mouth, its width is less than 2500 feet — a statement somewhat surprising when we consider that in the meantime it has received the waters of the Ohio, Missouri, Arkansas, and Red rivers. The same is true of many other rivers, especially those which do not flow into tidal estuaries.

The decrease in width is due to several causes. Rivers flowing through dry and hot regions lose enormously by evaporation,[1] and there are many well-known instances where their waters disappear entirely from this cause alone. Another common cause is the deepening of the channel, which thus permits an increased volume

[1] The evaporation is not only from the surface of the stream, but from the entire width of ground saturated by it.

to pass through a narrower passage. But the chief cause is to be found in the fact that in the lower course of a river the stream flows between banks it has itself made, and having made them it can as easily cut them away. Wherever the volume of the water is too great to flow between banks, it sends off tributaries instead of receiving them. Thus, along the lower Mississippi the offshoots are so numerous that only an expert pilot can pick out the main channel: and one can travel thousands of miles on the Amazon or the Madeira without ever touching the principal stream.

It is a very general supposition that the divide between two rivers is the crest of the mountain-range between them. This is commonly not the case. Thus, the sources of the Columbia, Klamath, and Pitt rivers are east of the Sierra Nevada and Cascade Chain of mountains. The Delaware and Susquehanna rivers have their head waters west of the main crest of the Appalachian Mountains, while the Great Kanawha, a tributary of the Ohio, rises east of this crest.

One of the best examples of a divide is found in the Yellowstone Park. Between Yellowstone and Shoshone lakes, at the summit of the highland, is a small body of water known as Two-Ocean Pond. During times of high water this pond discharges its waters from two outlets — one leading into the Yellowstone River and thence to the Gulf of Mexico; the other into the Snake and Columbia rivers, and thence into the Pacific Ocean.

We sometimes take pride in figuring dimensions to a closeness which is really an affectation of accuracy. It is rarely the case, however, that river-lengths are expressed to the fraction of a mile, but this is occasionally done. Now, such a proceeding is not only misleading, but it is absolutely incorrect. It is misleading, because it assumes that a river has a constant and fixed length. It is erroneous, because none but a few of the shorter streams in thickly populated centres have been so accurately surveyed that their lengths can be given to within a fraction of a mile. Large rivers like the Mississippi and Missouri are constantly varying in length. During seasons of drought the volume of water in the

Mississippi is so reduced that its current is considerably checked. It then must spread out and lengthen the sinuous curves for which its lower course is noted. But with the coming of the spring floods its current increases, and it begins to cut away the bars of sediment it dropped in its way, and goes to work straightening out its channel. In more than one instance the Mississippi has, by cutting across the neck of a long loop, shortened its course by twenty or thirty miles at a time.

All rivers flowing through great alluvial plains are thus erratic in their courses. During past ages the Mississippi must have flowed in nearly all the lower parts of the broad valley which bears its name, building its bed and banks higher than the surrounding land, and then cutting them away; lengthening its loops and curves in time of low water, and shortening them in time of flood. An instance even more remarkable than that of the Mississippi is the Hoang, a river of the Chinese Empire. This river because of the sudden and unexpected shifting of its channel is known as the Sorrow of Han, deriving this name from that of the province through which it flows. In 1852, it broke through its banks near Kai Fong, and abandoning its former course, flowed in a northeasterly direction, finally pouring its waters into the Gulf of Pechelee, at a distance of three hundred miles from its old mouth. By this catastrophe 2000 cities and towns were destroyed, and more than 2,000,000 people perished.

IX.

METEOROLOGY.

Heat. — It is not quite correct to assume that we receive our heat directly from the sun. On the contrary, the sun warms the earth, and the earth in turn warms the air. Our judgment of a warm day depends not on the intensity of the sun's rays, but on the temperature of the air. The truth of this may be seen by using a thermometer whose bulb has been coated with lampblack. When a thermometer of this kind is exposed to the sun, or even to a cloudy sky, the mercury mounts up to 120° or 130°. This extreme temperature is observed, although with an ordinary thermometer it may register below the freezing-point. Some years since the author was engaged in making meteorological observations just above the base of Mount Hood. Two thermometers were used. One, a blackened-bulb instrument, was exposed to the sun; the other, an ordinary thermometer, was shaded. The former stood at 112°; the latter at 28°. The sun's rays were hot enough to blister the face; the air was so cold that not a flake of snow melted except around the sun-charred trunks of the fir trees.

Atmospheric Moisture. — Almost invariably we see the statement, 'Warm air will hold more moisture than cold air.' This is probably the easiest way of saying that more water exists in the state of vapor at a high, than at a low temperature. As a matter of fact, the vapor of water is always present in the atmosphere; but it is equally true that the atmosphere has nothing to do with the moisture. The latter would be present whether there was any atmosphere or not.

The various elements of the air are independent of one another. Their relative proportions, aqueous vapor excepted, however, are constant. It is because of the constant changing of the percentage

of the vapor of water that we are apt to consider the latter as an intruding element in the atmosphere. When the temperature rises, a certain amount of water at the surface of the earth is vaporized, and exists in a gaseous state; when the temperature lowers, it is condensed. The gaseous water, or vapor, floats around in the atmosphere, it is true, but the other elements of the atmosphere do not affect it in any manner. It is a well-established law, moreover, that one vapor or gas is practically a vacuum for another, and this law holds true of air and aqueous vapor. The amount of water mingled with the air in the form of vapor depends on *temperature alone.*

A similar and equally inconsistent statement makes the winds responsible for the transference of aqueous vapor from one part of the earth's surface to another. Thus we frequently read that 'warm ocean winds carry moisture from the hot, tropical regions to the cooler temperate latitudes, where it is precipitated in the form of rain.' As in the preceding paragraph we are led to believe that the atmosphere is the responsible agent; and herein is the error. The moisture is borne *with* the wind, because a part of it; but the wind, *per se*, has nothing whatever to do with its movement from one place to another. Each component element of the atmosphere is a vapor which follows the laws that govern all vapors. Each expands or increases its bulk when heated, and the overflow passes to temperate latitudes. The currents of aqueous vapor are similar in force and direction to those of the atmosphere, but there would be currents of aqueous vapor whether there were any other atmosphere or not, and the currents of vapor would have about the same direction and distribution as they now have. The conventional way of treating evaporation and the transference of vapor as atmospheric phenomena is perhaps easier than the correct explanation, but it is a grave error to neglect the true explanation because it is more difficult.

The precipitation of moisture in the form of rain is commonly ascribed to the cooling of moisture-laden winds. Noting the fact that the moisture and the other elements of the atmosphere are

vapors which are independent of one another, the explanation is mainly correct. The manner in which the cooling of the vapor takes place is not always consistently explained. Wherever moisture blows from the ocean landward, a large proportion is precipitated in the form of rain. In this case the cooling and precipitation of the moisture is generally charged to the high mountain-ranges which border most coasts.

That mountain-ranges cool and precipitate considerable vapor is certainly true, but the main cause is the low temperature of the air over the greater area of land in temperate latitudes. The rain-bearing clouds which flood the plains of the Amazon come from the east, and there are no mountains along the coast to precipitate their moisture. Along the Chilian coast, however, the Andes are the chief agents which precipitate the moisture, for here is one of the few localities where the mountains rise higher than the rain-clouds.

In the broad expanse of the ocean where most of the rain falls, there are neither mountains or other land masses to cool and precipitate the moisture. Here the cooling is effected by the rising of the vapor above the surface. All vapors or gases expand as they rise from the surface of the earth, because of the lessened attraction of gravitation. But vapors cool by expansion, and the vapor of water is not an exception to the rule. A precipitation of rain, therefore, immediately follows. This law explains the almost constant rains within the rain-belt.

Winds. — In discussing the theory of winds we usually say that "the air in the equatorial regions, becoming warm, 'rises,' and colder air 'rushes' in to fill its place." Now, the warm air does not 'rise' nor does the cold air 'rush.' On the contrary, the cold air, because of its greater specific gravity, flows towards the equator and lifts or floats the lighter warm air. The warm air is specifically lighter because the heat expands it.

It is for this reason warm air is lighter than cold. The 'rising' of the warm air may be illustrated in this way. Put a chip of wood in the bottom of a basin, and pour water into the basin.

Now the chip does not 'rise' while the water 'rushes in,' etc. The water, because it is heavier, merely floats the chip, and this is what actually occurs in the case of the transference of air in equatorial regions; the colder air being the heavier floats the warm air.

Storms. — There is much confusion in the uses of the word 'storm' as applied to the disturbances which are variously known as 'cyclones,' 'typhoons,' 'tornadoes,' 'hurricanes,' 'squalls,' etc. As used by the professional meteorologist, a storm signifies any area of low barometer attended with high wind, rain or snow, thunder and lightning, or hail. Very slight areas of low barometer which are not accompanied by atmospheric disturbances are usually called 'depressions.'

Cyclones or typhoons are whirling storms which originate in the sea, and do not visit the land except as they blow over an island or touch the shore of a continent. The cyclone usually originates in the torrid zone within ten or fifteen degrees of the equator. The path of the cyclone or typhoon is approximately a parabolic curve; in the Northern Hemisphere it moves from southeast to northwest, and as it approaches temperate latitudes, gradually shifts about and travels towards the northeast. The whirl of the wind is in a direction opposite to that of the hands of a watch. In the Southern Hemispheres all motions are the reverse of those in the Northern Hemisphere. Cyclones are most prevalent along the course of the Gulf Stream, the Kuro Siwo, and the southern coast of Asia. The diameter of the whirl varies from fifty to two or three hundred miles, and the storm will often travel several thousand miles before expending its energy. The velocity of the wind sometimes exceeds one hundred miles an hour.

Tornadoes are whirling storms which are almost always confined to the land. The tornado invariably moves in direction from the southwest to the northeast quadrant in the Northern Hemisphere. The tornado-cloud, at its centre, takes the form of rapidly whirling 'funnel-cloud.' This funnel-cloud is the 'eye' of the storm, or vacuous centre of the whirl, and the vacuum is the result of the extremely rapid rotatory or whirling motion. The destructive vio-

lence of the tornado is confined usually to the immediate path where the funnel-cloud drags along the ground. With scarcely an exception the tornado occurs in the afternoon, seldom occurring before three o'clock, and rarely, if ever, after six o'clock. In a few instances, however, a tornado has been known to continue its course until an hour or more after sunset. Tornadoes are more frequent in the great plains of the United States than any other known part of the world.

It is thought that most rotatory storms are due to the overheating of the air next the earth's surface, it thus becoming relatively lighter than the cooler air above it. Finally a column of air starts upward, and immediately the colder and heavier air, by its greater weight, gradually settles to the earth, forcing the warm air next the earth through the channel made by the first uprush. As the air is forced up the channel it acquires a whirling motion that soon becomes rapid enough to create a partial vacuum in the centre. The vacuum thus produced is the funnel-cloud of the tornado and the chief agent of destruction. The velocity of the whirl is estimated to exceed, at times, 200 miles per hour. The diameter of the whirl varies from a few yards to many rods. Its direction in the Northern Hemisphere is contrary to that of the hands of the watch. The path of the tornado does not commonly exceed fifty miles in length; that of the cyclone of the sea may be several thousand.

The hurricane is properly a straight wind, although the cyclones of the West Indies and the typhoons of the Japan coast are often called hurricanes. The essential feature of the hurricane is velocity, and at the summit of Mount Washington a hurricane having a velocity of 200 miles an hour has been recorded.[1] The hurricane may occur during any season of the year or at any time of day. Its duration may be a few minutes or several days. It may blow from any quarter in a path varying from a few miles to a thousand in width. The blizzards of Dakota, the Chinook winds of Oregon and Washington, the northers of Texas, and the simooms

[1] This storm was accompanied by a temperature of —50°.

of the Great Desert may properly be called hurricanes, but whirling-storms should not be included among them.

Nearly all storms, whether of rain, snow, or wind, except local showers, hail-storms, thunder-storms, and squalls, are cyclonic in their general character, but lack the violence which characterizes the typical cyclone. They consist of an area of low barometer towards which the wind blows from all directions. Their direction is generally from the southwest to the northeast quadrant in the Northern Hemisphere. In the United States there are three general storm-paths which the great majority of storms follow.

Many, if not most of the storms sweeping over the United States originate in Dakota, Montana, and Wyoming. Sometimes their paths bend considerably southward, and include the territory lying as far south as the 35th parallel; but the greater number are included between the 40th and 50th parallels. The storms of this class are by far the most important of those which sweep over the Great Central Plain, and so many of them originate in Dakota and Montana that this area is facetiously spoken of as the 'weather factory' of the United States.

Another important storm-centre is the Gulf of Mexico and the Caribbean Sea. The storms originating in this locality commonly travel up the eastern coast of the United States, gradually turning eastward somewhere along the New England coast. Storms of this class are rarely found west of the Appalachian Mountains. These storms belong properly to the cyclones which follow the Gulf Stream.

The storms of the Pacific coast originate in the Pacific Ocean. Usually they travel in a westerly course, sometimes crossing the Rocky Mountains, but not infrequently taking a southerly course down the coast. In a number of instances it has been strongly suspected that a storm travelling in this direction crosses the Mexican Plateau to the Gulf of Mexico, where it gathers fresh strength and reappears as a fierce Atlantic cyclone. In several instances a storm which has been marked by an unusually low barometer has come from some unknown part of the Pacific, crossed the United States, continued across the Atlantic, and

finally disappeared in the great plains of the Russian Empire. It is well to remember that all general storms are rotatory, and that they differ from the typical cyclones in velocity and severity only.

Much has been said in late years about the electrical origin of cyclones and tornadoes. Not a few people are firmly convinced that rotatory storms are the direct result of some supposed electrical inequilibrium, inasmuch as lightning and other electrical displays frequently accompany tornadoes. Since the establishment of the Weather Bureau, the subject has been closely studied by Ferrel, Hazen, Finlay, and others, with results which fail wholly to establish any relation of cause and effect between electricity and tornadoes.

The Seasons. — In most books for pupils' use we are informed that there are four seasons, spring, summer, autumn, and winter, and usually the pupil is left to infer not only that these seasons obtain in all parts of the world, but also that there are no other climatological divisions of the year. Such a conception is very misleading, for in only a few parts of the world are the divisions of the year so considered. In parts of the United States and Europe the year is thus divided, but unfortunately the months in each division do not correspond. In the United States, for instance, the spring months are March, April, and May; while in Great Britain they are April, May, and June, and so with the remaining seasons of the year. It would perhaps be better to consider the equinoxes and solstices as the beginnings of seasons, but this is not the plan popularly followed. Furthermore, in many parts of the world there are but two seasons, the rainy and the dry. In San Francisco, for instance, where the difference between the average summer and winter temperatures is less than ten degrees, the division of the year into the ordinary seasons is an absurdity. Within the torrid zone, where the temperature is that of perpetual summer, the only divisions of the year are those which are marked by the prevalence or absence of rain, and there may be either two or four seasons, according as one is near the tropic of Capricorn or the equator. The rain-belt passes back and forth

with the apparent motion of the sun, and along the northern coast of South America there are two rainy and two dry seasons. In the frigid zones the only seasons are manifestly those of day or summer and night or winter. It is well to bear in mind, also, that the seasons of the Northern are the reverse of those in the Southern Hemisphere. This is true not only of those seasons marked by change of temperature, but also of those distinguished by the precipitation of moisture.

Glaciers. — No other subject of research has excited so much discussion, wise and otherwise, as the causes of the motions of glaciers, especially such as are found in the valley of the Alps, the Cascade Range, and the Alaskan Mountains. Upon the main facts attending the glacial motion there is quite a general agreement that the glacier flows very much like a river, its current being most rapid at the upper surface in the centre, and slowest at the sides and bottom. It adapts itself to all inequalities of surface as does a river, accelerating its rate in narrow or constricted passages, and retarding it in broad, shallow places. In other words, the glacier of the narrow valley is no more nor less than a river of ice, behaving in almost every respect like a river of water.

The question as to *how* it moves is the one concerning which no little acerbity has been developed. The following opinions, held by scientists of high standing, were impartially collected by Professor Prestwich of Oxford.

'Louis Agassiz supposed the motion was due to the infiltration of water into the fissures, cavities, and minute crevices in the ice, and its subsequent freezing within the glacier; and that this produced an expansion of the mass by which the glacier was pushed forward.'

'Mr. W. Hopkins considered that gravity was the main cause, since all glaciers in motion appear to repose on surfaces of sensible inclination to the horizon. The least mean inclination of the bed of any glacier in motion is about 3°, which gives a fall of about one foot in twenty.'

Neither of these hypotheses, however, explain how the ice is

held together, and adapts itself to the inequalities of its channel. To account for this, Professor James Forbes supposed 'ice to be capable of changing its form under the pressure to which it is subjected, in a manner similar to that in which a *viscous* mass changes its form under the same circumstances. It was found that the central portions of a glacier move considerably faster than its lateral portions, just as a viscous mass would move along a trough inclined at a small angle to the horizon; and, moreover, it was obvious that the general mass of a glacier did so change its form so as to accommodate itself to the changing dimensions of the valley down which it moved.'

Professor Forbes also found that the upper surface of a glacier moved faster than the lower surface. In one instance it was shown that the upper part moved twice as fast as the lower part. It was concluded, therefore, there were two motions, one due to sliding, and the other to viscosity.

'An experiment of Faraday's, who had observed that two pieces of ice in perfect contact would freeze together so as to become one perfectly continuous mass, though the surrounding temperature should be much higher than 32°, suggested to Professor Tyndall a remarkable property of glacier ice. He proved by further experiment the extreme facility and rapidity with which a piece of common ice, after being broken and crushed into numberless fragments, will reunite into one continuous mass of transparent ice. It is this process which has been termed *regelation*, that re-cements and holds together the glacier ice, notwithstanding the rending and fissuring to which it is subject. For ice, though plastic under *pressure*, is not so under *tension;* and this is the point which the theory of plasticity did not explain. While a viscous body, like bitumen, may be drawn out in filaments by tension, ice, far from stretching in this way, breaks like glass under such action.'

'Canon Mosely considered heat to be the cause of motion. He observed that a sheet of lead placed on a plane surface, inclined less than would enable it to slide by gravity alone, yet

tended nevertheless to move downwards when subjected to variations in temperature. The cause of this is that, when the lead expands by an increase of heat, gravity opposes its upward motion, while it facilitates its downward motion. When the temperature is lowered, the lead contracts; and here again, in consequence of gravity, the strain is downwards. Consequently, with every change of temperature there was a slight displacement of the lead downwards, with a force such that the nails with which it was fastened were drawn out of the wood. Canon Mosely contended that an action analogous to this was the proximate cause of the descent of glaciers; that the expansion and contraction of the ice produced by the heat of the sun on the inclined surfaces on which it moved, have no other than a progressive downward movement.'

Not unfrequently the statement is made that glaciers are found 'in the highest parts of high mountains,' or that they are 'always above the limit of perpetual snow.' Such assertions as these are very misleading. The altitude at which glaciers are found depends almost wholly on latitude. In low latitudes they are usually at great heights, but in high latitudes they are rarely at a great height above the sea-level. The Greenland, the Alaskan, and the Norwegian glaciers nearly all terminate in the sea, and have their beginnings at no great distance above it. The glaciers of the Alps and Himalaya Mountains, on the contrary, are at considerable heights. The upper parts of permanent glaciers are above the limits of perpetual snow, it is true, but the lower parts are usually pushed far below the snow-line, and, in the Alps, well into the region of cultivated fields.

Icebergs. — It is commonly inferred either by statement or by inference that icebergs carry large boulders, gravel, and other detritus at their bottoms. These, in the case of the Greenland icebergs are finally deposited off the Newfoundland coast on what is known as the Grand Banks. More than one book has an iceberg pictured in full, carrying a load of round, water-worn boulders at the bottom, and in order to show the process of bank-making, boulders are conveniently dropping from the ice. This is cer-

tainly a very pleasing theory, and one which never fails to interest children. Let us look at it in the light of facts. In the first place, icebergs do frequently carry boulders, but the latter are carried, not in the lower part of the berg, but on the upper surface. Occasionally boulders will melt a passage into the interior of the berg, but these are exceptional cases. The berg does not pick up boulders, but the latter roll down the sides of the slope and fall on the berg when it is a part of a glacier. Secondly, if the iceberg picked up its load of boulders and carried them at the lower part, the latter would never be carried so far south as the Grand Banks; on the contrary, they would be dropped long before the berg had passed through Davis Strait. That the Grand Banks have been built of the gravel and boulders which have been transported from the Greenland moraines is certainly among the possibilities, but at present it can be considered as a theory only, and not as an established fact.

It is a commonly accepted assertion, also, that all glacial boulders and till present the planed surfaces scored with parallel lines, which we so commonly see pictured as witnesses of the peculiar erosive action of glaciers. It is true that such planed boulders bear indubitable evidence of glacial action, but they are by no means common or easy to find. Most of the glacial till and gravel has no characteristics that distinguish it from ordinary water-formed gravel, and it is only when an angular fragment is held by the ice, as in a vise, that one or more of its surfaces is planed off and scored with the parallel scratches which reveal its character.

While it is generally known that the icebergs of the North Atlantic Ocean are born of glaciers of the west coast of Greenland, it is a matter of surprise to find how comparatively insignificant in extent is that part of the coast where the icebergs are calved. Along the 1200 miles of explored coast, the results of the Danish explorations show that only about a score of the glaciers extending any distance inland produce large icebergs, and of this number less than a dozen are glaciers of the first rank. The huge icebergs that are so menacing to the New York and Liverpool steamships

are not the progeny of Humboldt Glacier in Kane Basin, but of the larger glaciers between the southern shore of Disco Bay and Upernavik. It is in the fjords of this part of the coast that ice-streams with a frontage of three miles and a thickness of 1200 feet were observed pushing their enormous masses down a slope of less than one hundred feet to the mile, at a rate of more than thirty feet per day.

We frequently find traces of the home life of our English ancestors wrapped up in the proper names with which we are intimately acquainted. The suffix 'ton' takes us back to the time when the Saxon farmer surrounded his holding of land with a *tun* or *hedge*, and in time the land thus enclosed became his 'town,' and, as the farm and its village became a thickly peopled centre, we still find the old name clinging to it. Thus St. Botolph's town became Bos*ton*; the town by the sea, Mer*ton*. In a similar manner, Nor*ton*, Sut*ton*, Eas*ton*, and Wes*ton* designate the towns which are respectively north, south, east, and west of a given locality. The suffix 'ham,' equivalent to the German 'heim,' signified that it was the *home* of the possessor. We find abundant traces of this word, as the names Old*ham*, Birming*ham*, Chelten*ham*, etc., serve to testify. The suffix 'by' has the same meaning as 'ton' and 'ham,' but it is of Danish origin. It is therefore still another witness of the incursions of the Danes. Thus we have Rug*by*, the town on the rock; Rig*by*, the town on the hill; Der*by*, the town on the river or water, and a host of similar names.[1] But while the ignoble people of his thrall were content to surround their holding with a tun or quick-set hedge, their lordly master enclosed his own feoffment with a 'burh,' or fortified wall. Hence we have the 'burghs,' 'burys,' and 'boroughs' which are attached to so many names all over Western Europe. Occasionally there was to be found some plucky fellow who submitted to the thrall of no lord. His 'burh' was an acknowledgment of his independence, and we have perhaps half a score of Free*burghs* and Frei*borgs*. Still another witness of the incursions of the Norse rovers and adventurers remains in the suffixes 'wick,' 'thorpe,' or 'dorf,' and 'garth' or 'guard.' The 'garth' (or guard), like the 'ton,' was the place *girt* in. We see a trace of the name in the English *yard*, and the suffix is plainly retained in such names as Apple*garth*, etc. The 'thorpe' or 'trop' is manifestly Danish, and like the German 'dorf' or the Saxon 'ton' signifies a village. Thus we have Ogle*thorp*

[1] Even to this day we have the 'by'-laws; that is, the laws which governed the 'by,' or town.

(Olga's village) and Win*throp* (Wynne's village). The 'wick' or 'wich' also bears testimony to the Norseman's visits. These Norse rovers were no better than any other pirates. For the greater part they lived near the sheltered bays and indentations, which are to this day called 'vigs' in Norway, and the plucky sailors were finally called '*vik*'-ings. Nowadays we like to call them sea-kings, but they were not kings in any sense of the word; they were only impudent robbers who raided the defenceless 'bys' and 'tons.' There is an occasional 'wich' or 'wick' among the sheltered inlets in the interior of Great Britain; but if we look at a good map, we shall find that most of them — nearly all, in fact — are on the eastern shores. They extend from Har*wich* in the southeast of England to Caithness *Wick* in the northeast of Scotland. Only a few, War*wick*, for instance, are found in the interior.

But even before the Danes or the Kelts had levied their tributes upon the Saxons, it is more than likely that the Gaels had established strongholds in England, for their 'duns,' or fortified hills, are scattered all over the country. Lon*don* itself, the city of the Lundusi, was at first a fortified stronghold of this kind, built on the slight elevation where St. Paul's Cathedral now stands. Thus we find Abing*don*, the abbey on the hill; *Dun*kirk, the church on the hill; *Dun*edin the *hill* of St. Edwin. We see the same root also in *Dum*fries, *Dum*barton, *Dun*dee, the fortified *hill* on the Tay, and in Ercil*doun*, which, like the German Hörselberg, means Ursula's Mountain. A more graphic example is the low range of hills known as the South *Downs*.

While the Norse settlement at the head of the estuary was designated as a 'wick' or 'wich,' the Gaelic stronghold at the mouth of the river was an 'inver.' Thus we find such names as *Inver*ness, and *Inver*esk, the town at the mouth of the 'esk,' or river. The Welsh 'aber' has a similar meaning, and every good map of the British Isles will show scores of such derivatives.

But the Roman invasion, as much as any other series of events, brought in a flood of new names. The conquered people were at no loss for names to apply to their strongholds, as we have

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they were not
impudent robbers
There is an
inlets in the
map, we shall
the eastern
of England to
a few, Warwick,

But even
upon the Saxons,
lished strongholds
are scattered
Lundusi, was at
slight elevation
find Abingdon,
hill; *Dunn*
in *D*

to the Severn

ern to the

wycliffe's dust

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as the waters

root in *Severn*, and in *Afton*. It occurs in

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we call brandy, but which the French call *eau de vie*.
rus (*Bous*, an ox, and *πορος*, a ford) is the only genuine
Thames extended in width as far as Sydenham Hill'

already seen, but to these the Romans added the more high-sounding 'castra,' a word which in the various forms of 'chester,' 'cester,' and 'caster,' accordingly as the *camp* was pitched among the Saxons, in the old kingdom of Mercia, or among the Danes, has been perpetuated in half a hundred proper names. Thus there is Don*caster*, the camp on the Don; Glou*cester*, the camp of the Glevi, or Gloui; Man*chester*, the camp on the minch, or estuary. The present town of Chester encloses *the* camp, and the old walls as well as parts of the castle are much the same as they were when the castle was garrisoned by Roman soldiers.

Even the most common names of both natural and artificial features have come to us directly or indirectly, as a result of the Roman invasion. Our word 'street'[1] is the equivalent of the Latin *stradum*. The *Capitol*ine Hill of the ancient city has given us 'capitol'; the *Palat*ine Hill, 'palace.' 'River' comes to us from the Latin *rivus*, a small stream, and we find in it a marked similarity to the Italian *riva*, and the Spanish ar*royo* and *rio*. We have unhesitatingly tacked some form of this word on many English words which have the same meaning, and we are unconscious of any tautology in speaking of the River Avon, or the River Thames, although both specific names are identical in meaning with the generic term. We are also just as careless in speaking of the *Rio* Grande River, the Yang tse *Kiang* River, the Amoo *Darya* River, or the *Wad* el Keber (Guadalquiver) River. Yet in every instance the italicized word signifies flowing water.

Professor Grove has shown that the great majority of the names of English rivers may be reduced to four in number. They are mainly Keltic words, and some of them may be traced clear across Europe, as silent witnesses of the westward march of the Kelts or Kymri. Some of these names were latinized during the Roman occupation; all of them show the wearing effects of time, for words suffer no less from erosion and corrasion than the things they designate. The four roots are 'uisge,' 'avon,' 'door,' and

[1] There were no paved streets in Britanny until the Romans constructed them.

'don.' Rather strangely these roots have been implanted into America in but few instances.

The first form, *uisge*, has given us the word *whisky*,[1] and it is a withering satire to find that in no other instance does this word obtain a place in American geography. We find corrupted forms in the *Wisk*, the *Usk*, and the *Esk*. It occurs in *Ex*eter; in *Ax*minster, the church (or minster) on the Ax; and in *Ox*ford, which had nothing to do with oxen,[2] but which was simply a fording place on the river (ox). Possibly the *Ox*us of Asia has the same derivation. There is little in *Ax*minster to remind one of *Aix* la Chapelle, but a moment's inspection will show that they have a similar if not a common meaning. *Ux*bridge refers to the time when a bridge first spanned the Ux (river), and in a similar manner *Ax*bridge implies its own meaning. In the Wishton-*Wish* we find another form of this root, as also in the broad estuary called the *Wash*. *Ouse*, *Ose*, *Ousel* (little Ouse), and Ousburn, are also forms of the same root; so also is Oise, a small stream in France. We find it also in *Ash*burn, the basin (or clearing?) of the Ash, and in still another form it occurs in Tham*es* (Tam *eisis*, the broad water[3]) and in the *Wes*er of Germany. On the authority of Professor Grove there are more than fifty streams, and a multitude of names of places derived from this root.

From *avon* we find also many derivatives. *The* Avon has been made famous in the lines: —

> The Avon to the Severn runs;
> The Severn to the sea.
> And Wycliffe's dust shall spread abroad,
> Wide as the waters be.

We find the same root in *Severn* and in *Afton*. It occurs in *Evans*ton, the river beset with hedge, and possibly in *Ivan*hoe.

[1] It originally meant 'water of life,' and in this respect is synonymous with the liquor which we call brandy, but which the French call *eau de vie*.

[2] The Bosphorus (*βοῦς*, an ox, and *πόρος*, a ford) is the only genuine 'ox-ford.'

[3] Formerly the Thames extended in width as far as Sydenham Hills.

We find it likewise in *Inn*sprück, the bridge across the river; in Rhine (ren afon), the swiftly flowing stream; and in Seine (sen afon), the sluggish river.

Door surpasses even *usige* in the territory over which it is distributed. There are several rivers having this identical form of the root, and we readily perceive it in such names as *Dore*, Lo*dore*, *Dover*, *Dura*, and *Duir*. This form also leads to *Thur* and A*dur*. *Der*went (*dur* gwyn), the clear stream, is likewise a derivative. Derwent became *Darent*, and the latter was shortened to *Trent*, and to *Dart*. In this form we may recognize it in *Dart*mouth; and in still another form, as *Trow*bridge. In France we find the same root in the name A*dour* and *Dor*dogne; in the Iberian peninsula it appears as *Douro* and *Duero*.

Don is also a very common root signifying flowing water. There is a river bearing this form of the name in England, and another in Russia. It has been immortalized in the song, —

'Ye banks and braes o' Bonnie *Doon*,'

and we find it also in the various forms of 'Dun,' 'Dean,' and 'Devon.' It occurs in *Dan*ube, and possibly in the tautological Dor*dogne*. In the north of England it is the 'Tyne'; and in the south the 'Teign.'

Another root signifying running water is found in such names as *Aar*, *Arve*, *Aare*, *Au*, etc. These names never belonged to the language of the Kelts, and it seems highly probable that they carried them to the British Isles, for we find it in Tam*ar*, which, like Thames, means *broad water*. As a matter of fact we can trace the wide path traversed by the Kelts as they pushed their way westward. Their track lay just within the French coast, and their names are scattered from Draguignan through Nimes to Bèziers — from Marseilles all along the Gulf of the Lion, leaving a narrow strip bordering the immediate shores, distinguished by a fringe of Latin names. Now it is hardly reasonable to imagine that the Kelts avoided the immediate coast, nor is it any more reasonable to suppose that Latin names should have

supplanted those of Keltic origin here and nowhere else. An explanation suggested by Professor Geike offers a much more probable solution, and a study of the physical geography of the region will help demonstrate the problem. All along this lowland coast, the rivers bring down yearly an enormous quantity of silt. Next to the Po, the Rhone probably extends its delta seaward more rapidly than any other river of Europe. Within historic times the Po has silted up the northern part of the Adriatic Sea to no inconsiderable extent. The town of Adria, a seaport in the time of Julius Cæsar, is now twenty miles inland, and Pisa, also a former seaport, is now seven miles inland. In fact, the Durance, which once flowed directly into the sea, now pours its flood into the Rhone just in the same manner as the Red River has been absorbed by the Mississippi. These facts point out what is probably the true explanation. Since the westward march of the Kelts, the shores of Southern France have encroached on the Mediterranean Sea, and the narrow strip of alluvial coast thus formed has been built upon by descendants of the Latin race. Written history furnishes little or no evidence upon the question; the names, however, stand as mute but living witnesses.

Among words carried to Britanny is one that is identical with our word 'lake.' In the Latin form it is *lacus*, but among the Gaels and Kelts it has the forms 'lough' and 'loch.' In some instances the name was given an estuary, or possibly a lagoon, but in the majority of cases the 'lough' is a lake. Inasmuch as we find the name in Switzerland and Germany, we may conclude that it is another witness to the Roman invasion, following the Roman legions just as Mille 'Lacs' (thousand lakes) and Fond du 'Lac' (end of the lake) followed the Jesuit missionaries to our own land.

Our Teutonic stock of people were not men of great learning, and any body of water extending beyond their horizon was to them the sea. We therefore have a score or more of insignificant estuaries and partly enclosed lagoons with this presumptuous title. Even the Zuider (south) Zee has been thus dignified. The Danes designated the sandy spit which *jut*ted into the shallow waters of

the North Sea, *Jut*land; while the large island near by they called the *Zee*land. Possibly for a similar reason the large islands southwest of Australia were called New *Zea*land. It remained for the Latin language to give us a name for the grand divisions of water which we call 'oceans,' and then, as a half apology for the narrow vision of our ancestors, we have rechristened the whole expanse of water as the sea. The mythical land 'Atlantis' has given a name to one ocean; 'Arcturos,' the North Wind, another; while its gently tossing billows and mild behavior have heralded the broadest ocean as the 'Pacific' or 'peace-maker.'

The Latin *strictus*, choked, has indirectly yielded our word 'strait,' though it comes to us through the old French *estreit*. It is not common in the neighborhood of the British Islands, the French 'channel' (from *canula*, a little tube) being generally employed. Formerly the word *minch* was much used, and we still find it applied to the channel which separates the Hebrides from Scotland. This word, which is probably the same as the French *manche* (now a 'sleeve'), means a 'gut,' and we find the latter in common use. *The* 'Gut' is the Strait of Gibraltar. We find it also in the *Gut* of Canso, in Katte*gat*, and in Hell*gate*. The last named had originally the form 'Horllgat,' that is, the whirling strait, but people make short work of words, and so Horllgat became Hellgate. All along the Danish coast we find the term *belt;* even the sea is called the *Baltic*, and a moment's reflection will tell us why it is called so. The *sound* is also a word we have used for many hundred years. It is now any broad strait or channel; but it was formerly a place where ships could 'swim' (*sundan*) at anchorage.[1] Nowadays we use the word to designate any broad and shallow channel, such as Long Island Sound. It would not be improper to apply it to the North Sea, but it is hardly correct to apply it to the land-locked shoals off the Carolina coast, for Albemarle and Pamplico Sounds are not sounds, but lagoons.

Our American words are quite as rich in historical reminiscences

[1] It is also thought to have received its name from the fact that its bottom could be reached with the *sound*ing line.

as those of the old world; but unfortunately, in our greed for the more material things of life, we have lost sight of the treasures of history we might have possessed. We have a few relics of the Mound Builders whom the people we call 'Indians' drove out of the land many centuries since. They left no written language beyond a few picture inscriptions on the rocks, and if we wish to learn anything of their spoken language we must look for it in the jargons of the Indians who conquered them. It is scarcely more than three hundred years since the conquest of the Aztecs by the Spanish adventurer Cortez; and yet there is scarcely a vestige remaining from which we may study their history. And if so little can be told from these, how shall we set to work to learn the history of the people whose dismantled walls of burned brick are now fifty feet below the surface of the Mississippi Valley. Truly the students of American geography and history have wonderfully rich fields of research before them.

The geographical names in North America with which we are most familiar are mainly derived as follows: —

Aboriginal names.
Names introduced by the English.
Names introduced by the French.
Names introduced by the Spanish.
Accidental and incidental names.

In addition to these there are a few names of Dutch derivation, a number of Scriptural names, and a few waifs that have been picked up from other parts of the world.

The aboriginal names are perhaps more abundant than any other one class, and we find them scattered almost uniformly over the continent. Perhaps they are of remote Turanic origin: certainly those of the northwest are, for they betray in many ways their Mongol descent. Many of them retain their former sound; but we must recollect that not only the aboriginal inhabitant had no written language, but he used many sounds that have no equivalent in English, French, Spanish, or German. It is well to think

of this when we wrangle over the spelling of such names as Alleghany, Aliaska, Kadiak, Mackinac, Sheboygan, and the like. Some of the aboriginal names in their present form have a most familiar French, or perhaps a Spanish flavor about them. There is a reason why they should; for in some future century the archæologist will reconstruct a history of the prehistoric races, and mark out the path of the Spanish conquest or the line of the French settlement with as much vividness as though he had been a participant. He will demonstrate how the Indian jargons were modified by the Spanish, and how in a succeeding period the Hispanio-Indian dialect was again changed by attrition with the Anglo-Saxon people. As an instance, among the Indians of Oregon 'water' was designated by a word sounding like *walla* — a word which has been preserved in the names Walla Walla and Wallula. There is a beautiful river of which has long been sung in most delightful poesy —

> "Onward ever, lovely river,
> Softly falling to the sea.
> Time that scars us, maims and mars us,
> Leaves no track or trench on thee."

This river as nearly as can be reproduced in English sounds was called the Wallamet. Under the influence of the French traders it became *Ouilamette*. Then the Anglo-American farmer came, and quickly shortened it to *Willam'ette*,[1] and now there is a growing custom of cutting the word down to *Wilamet*. The name of a town in Texas has a similar history. A party of vaqueros camped in a beautiful spot, and, with the poetic spirit which fires even the cowboy's heart, named the place *Buenos*. On the heels of the vaquero came the imperturbable Yankee trader. He could not see why a name should be written with one set of letters and sounded by another. As a sickening result, the town is now plain *Wano*. A somewhat similar change occurred in a certain Cali-

[1] A similar fate befell 'Ouachita,' which now usually appears in the form of *Washita* and *Wichita*. The change is the result of the same law whereby 'guard' has become *ward* and 'guarantee' *warranty*.

fornia mining camp which boasted the not unmusical name San Juan. But San Juans are very numerous on the Pacific Coast, and inasmuch as the combined trader and postmaster had no end of trouble with the confusion of names, once, in a fit of righteous indignation, he changed the name to Johnstown, and so it remained until it fared the fate of all worn-out diggings.

But the Spanish conquest has left us many entertaining souvenirs. The notched, saw-toothed crests gave us the word 'sierra' (saw), which is so aptly applied to the ranges of the western highlands. Brackish, *salty* waters have given the name 'Salinas' to a dozen streams. The *snowy* crests of the mountains suggest the name 'Nevada.' Their sharp, *needle*-like spires prompted the name of 'Farallones' to the islands near the Golden Gate. Turbid waters richly colored with *red* sediment gave the 'Colorado' its name. The *wolf* is remembered in Point 'Lobos,' the *butterfly* in 'Mariposa,' the *angelic hosts* in Los 'Angeles,' the clumps of *willows* in 'Saucelito,' the *wild cherries* in 'Cerritos,' and the forest of *white oaks* in 'Albuquerque.' The apostles and canons of the Church have been numerously represented in hundreds of such names as San Juan (St. John), San José (St. Joseph), San Diego (St. James), San Pablo (St. Paul), and a host of lesser saints. Cape Gracias a Dios was probably suggested by the same feeling of reverence that prompted Captain Hall to name the haven in which he found safety '*Thank God* Harbor.' The pleasant prospect or surroundings have caused the name 'chico' and 'bonita' to be applied to a score of places. One peculiar feature marked the conduct of the Spanish explorer: he rarely ever commemorated the living — much less himself — in the names applied to places. He was not, however, unmindful of the beautiful in nature, as the names 'Blanca Reina' (white queen), 'Colorado Chiquita,' 'Pasadena' (a corruption of a word meaning *key to paradise*), testify. With the scarcity of verdure that characterizes the Basin Region it is not singular that so many delightful nooks dotted with groves of mezquit should be named 'Palo Verde.' In gratitude at the discovery of the potent *Micromeria*

douglasii, an herb which cured his ague, banished his rheumatism, and invigorated his whole system, he named the island where it was found 'Yerba Buena.'

But these were only diversions, for his whole energy was devoted to finding enough canonized saints whose names might be distributed over the country; and if there were not enough of these, he could, as a last resort, propitiate his Satanic majesty in such names as Monte 'Diablo.'

We of course expect to find French names scattered over the north and northwest, just as we found the Spanish names in the west and southwest. The wide swath of French names extends along the St. Lawrence to the Great Lakes, and then the stream follows the Mississippi almost as regularly as the flow of the river itself, terminating in Louisiana in a broad delta, and flanking both sides of the river almost like the drift that has been tossed along the banks by the flood. They follow along Renè Lake, which the modern trapper has turned into 'Rainy' Lake. In the rapids of the St. Lawrence which we familiarly know as 'La Chine,' we find testimony of the early explorer's belief that the St. Lawrence poured its flood as far east as China. In 'Prairie du Chien' we may learn that the prairie *dogs* were abundant as far east as the Mississippi. 'La Crosse' still perpetuates the place where the Indians met to play their famous game, and 'Detroit,' the place where the *three* rivers had a common basin.[1] 'Eau Claire' testifies to the pure *transparency* of the *water*, but in Trempelau we are left to guess whether an unfortunate individual was *steeped* in just plain *eau* or in *eau de vie*. 'Baton Rouge,' the *red staff*, was, without doubt, suggested by the bright red bark of the tall, slim cedars that grew near the *Mish a se ba*, or, as we now say, the 'Mississippi.' The 'ouragan' which blew so fiercely from the snow-clad *Wind* River Mountains, is recalled in the *Oregon* — the river now named Columbia.

The French explorer was as frugal with the names of his saints as his Spanish contemporary was profligate. In only a few in-

[1] It may be derived from *d'etroit*, the strait.

stances, such as St. Louis, St. Joseph, St. Claire, and Ste. Marie, are they remembered. He was also as modest about commemorating the names of his living brethren as the Spaniard, and it remained for the Anglo-Saxon descendant to give the names De Soto, Marquette, Hennepin, La Salle, and Joliet, the prominence they deserve.

But not so with the enterprising Anglo-American. He has plastered his name over the continent with a freshness that would do credit to the proprietor of a cure-all bitters, and we find the whole country bristling with Smithfields, Jonesburgs, Brownsvilles, and Thomastons. When all the resources of his own family name were exhausted, he began with the names of lesser lights, — usually those of former presidents, — and a state that has not a duplicate set of these is indeed poverty stricken. Then he finally fell back to natural resources, and we find Willow Creeks, Currant Creeks, Oak Creeks, Cherry Creeks, Cedar Creeks, Cottonwood Creeks, Rock Creeks, Clear Creeks, and Beach Creeks by the hundreds. Moreover, every one of these has a North Fork and a South Fork, or else an East Fork and a West Fork. If Mineral City in the abstract is not sufficiently comprehensive, Gold Hill, Silver City, Iron Mountain, Leadville, Placerville, Oroville, Soda Springs, Copperopolis, and Carbondale are called into requisition. When all others were exhausted the 'Half Way House' was a never-ending resource to be drawn from. It was equally serviceable at all times, and under every condition of civilization. It could be anything from a marble palace to an Indian wick-i-up, and it could be situated anywhere from one-third to four-fifths of the distance between places. This name was indeed an El Dorado.

The gay and festive vaquero has likewise had no small share in the geographical distribution of names. His selections are certainly not classical, — which is in their favor, — and they may not be overwhelming in their degree of refinement. The severest critic, however, cannot complain that they are lacking in vigor of expression. As witnesses there are 'Boot-jack Ranch,' 'Jackass Flat,' 'Dirty Devil River,' 'Dead Mule Gulch,' 'Devil's Kitchen,' 'Shoo

Fly,' 'Shanty-town,' 'Slab-town,' 'Hang-town,' 'You Bet,' 'Whiskey Flat,' 'Poker Flat,' 'Hell's Delight,' and 'Hell Roaring Forks,'—all of which are names that are, or have been, in legitimate use. Yuba Dam offers an apparent apology in its orthography, though it is unfortunate for the apology that the name existed long before a dam was built across Yuba River. But the vaquero, the prospector, and the muleteer are transitory, and so are often the names they have bestowed. Nevertheless, these names, undesirable as they may seem, are just as important in history as though they had been the choicest terms culled from classical literature. The cowboy was a more potent factor in the geography of the West than the merchant or the school teacher; for, in spite of his short-comings, which were not few, he was a man of courage, of determination, and of wonderful breadth of character. He was the pioneer explorer, in whose footsteps the professional explorer followed. In many respects he was unconsciously a greater geographer than any of his more learned followers, who depended upon him as guide and ward. He was the advance-guard of civilization, the necessary man for the times; and when the times were changed, he disappeared.

It is a fortunate thing, too, that a disposition to restore the old Indian names is growing little by little. And why should it not be? Where can we find names that have a clearer and more musical ring than Wallu'la, Parowan', Uin'tah, To'roweap, U in' karet, Pah u'tah, Kla ha'lem, I'vanpah, Tu il'la, Un com pah' gre, Kai par'owits, Awa'pa, Cu ca mon'go, Ton a wan' da, and a host of others equally crisp? One could not easily find better ones, and in them the archæologist will find quite as rich a treasure as the storehouses of English names have yielded.

XI.

POLITICAL AND OTHER BOUNDARIES.

It is rarely that one questions the accuracy of boundary lines. This arises partly from the reason that the boundary line has little of practical significance to either teacher or pupil, but mainly because we are apt to look at boundary lines as things that have been established beyond doubt. As a matter of fact there are very few boundary lines in existence that are so definitely settled as to leave no room for misunderstanding. In many instances state maps have been compiled by aggregating the surveys of private properties into towns and counties. From the latter the map of the state is put together. Such maps, though consistent in themselves, unfortunately do not join together with any degree of accuracy. For instance, when the official maps of Illinois, Missouri, and Iowa, reduced to a uniform scale, are joined, the Mississippi River widens out to a broad lake in some places and disappears between overlapping borders in others.

Boundary lines are mainly of three kinds, — the crests of mountain-ranges, rivers, and surveyed lines marked by posts or cairns. In the case of a mountain-range there is not likely to be much trouble resulting from indefiniteness of position, from the fact that the range is often wide and is more or less impassable. Furthermore, the crest may lie in a barren, uninhabitable region. The main difficulty lies in ascertaining whether the range as laid down on the map conforms to the actual range; and secondly, in locating the crest of the range. It is by no means easy to do either of these. In the latter case, drawing a line along the hachures of a map is one thing and locating the crest of a broad swell of land is quite another. In the former, it is by no means certain that, even on the best maps, the hachured range corresponds with the

actual one. The plotting of mountains on the ordinary map is largely a matter of guess-work. In evidence of this it is necessary only to compare the various maps of the Rocky Mountain region with one another. In the specialization of ranges no two maps reasonably correspond. The mechanical impossibilities of correctly plotting ranges on small maps are such that chartographers have too frequently fallen into the habit of delineating the topography more with a view to convenience and artistic effect rather than accuracy. A case in point is that of the territory of Alaska. The boundary of the southeastern strip, according to the treaty with Great Britain, 'followed the summit of the mountains situated parallel to the coast.' Explorations have shown, however, that there were so many breaks, and such a lack of continuity of the various ranges, that the supposed crest has practically no existence.

A river boundary, especially if the river be navigable, is always a menace to peaceful relations. This was notably the case when the Rhine was a boundary between France and Germany. Human nature is the same the world over, and it is only natural that each nation should want both sides of the river. Even in the United States river boundaries are a never-ceasing source of annoyance. Usually, where a river separates two political divisions, the dividing line, by statutory law, lies in mid-stream. But inasmuch as the stream which flows through alluvial land is constantly changing its course, the mid-stream of one year lies in quite a different position from the mid-stream of the following year. In the case of the lower Mississippi River the formation of a cut-off across the neck of a long loop will frequently leave large tracts of land in such a position that no statutory law will decide the ownership. At the occurrence of Davis's cut-off at Palmyra Bend, Mississippi, a body of land about thirty miles in circumference was separated from the state to which it rightfully belonged. Island No. 74, between Mississippi and Arkansas, is practically out of the United States, for by statutory law the boundary of Arkansas extends to mid-*stream*, while that of Mississippi reaches to mid-*channel*. Island

No. 74 lies between these two points, and is, consequently, without the borders of either state.

The variation of the compass needle has caused many irregularities in boundaries where the latter were established by compass surveys. So faulty have these been, that much bloodshed has resulted from the inaccuracies of such surveys. The line commonly known as Mason and Dixon's line was surveyed by two English astronomers (after whom it was named), in order to settle the bloody disputes which arose from an imperfectly surveyed boundary between Pennsylvania[1] and Maryland. A casual inspection of any large map of the New England States will show that in scarcely a single place does a state boundary coincide with a parallel or a meridian. The wavy northern boundary of Vermont is undoubtedly due to imperfectly adjusted compass boxes, and the breaks in the southern boundary of Massachusetts are due to alleged errors in the former surveys. Indeed, the errors of survey have always been a remarkable feature in the boundaries of the state. During the recent topographical survey of the state these 'errors' received a searching investigation with the result that the error was always in favor of Massachusetts. The small triangle of land clipped from the southwest corner of the state, known as Boston Corners, was ceded to New York, in order that the officers of that state might put a stop to the liquor traffic in the locality. The rectangle projecting from the southwest corner of Connecticut is the result of a compromise between that state and New York. Connecticut desired a more extended coast along the Sound, and, in return for the rectangle mentioned, ceded to New York a strip of equal width to be cut from the western edge of the state.

The Missouri 'Jog.' — The offset in the southeastern part of Missouri, consisting of the counties of Pemiscot, Dunklin, and New Madrid, furnishes some interesting history.[2] 'At the time of

[1] The boundary between Pennsylvania and New York is theoretically the 42d parallel; practically, however, it is a crooked line varying from 760 feet north to 350 feet south of this parallel.

[2] The history of this 'jog' was furnished through the courtesy of Hon. A.

the admission of Missouri, Colonel John Walker owned an extensive plantation in Pemiscot County. Walker was a man of more than ordinary ability, and was generally looked on as a leader by the people of that region. All this country was then recognized as a part of Missouri Territory. New Madrid was an important trading post, and an immense traffic was carried on between the French and Spanish traders and the various tribes of Indians in Southern Missouri and Western Tennessee. New Madrid claimed and exercised jurisdiction as far south as Pemiscot Bayou, which flows into the Mississippi River about three miles north of the present line, between Missouri and Arkansas. Walker acknowledged allegiance to the territory of Missouri, inasmuch as the laws were administered by the authorities at New Madrid.

'When Missouri applied for admission into the Union, the parallel of 36° 30′ was suggested as the southern boundary of the new state. Walker at once saw that if this line were adopted, he would be left in an unorganized territory, inasmuch as the line crossed the Mississippi about twenty-five miles north of his possessions. His worldly means as well as his indomitable pluck gave him influence, and he set out to work in earnest to prevent the threatening disaster. He interviewed the commissioners appointed to fix the boundary, and so eloquently did he plead his cause, that the commissioners finally agreed to take the area north of the 36th parallel, and between the Mississippi and St. Francais rivers into the state.'

The Minnesota 'Jog.' — There are few students of geography who have failed to notice the peculiar affect upon the northern part of Minnesota. It is the only place where the boundary of the United States, the Alaskan possessions excepted, reaches farther

A. Lesueur, Secretary of State of Missouri. At the time the author's request for the information was received, nothing concerning it was on file in the archives of the state. Mr. Lesueur immediately began an investigation of the matter. The facts were finally obtained and presented by Senator George W. Carleton, after an extended research. All the parties concerned in the history of the offset are dead, and the information was passing into the traditional state.

north than the 49th parallel. This irregular knob is another instance of the difficulties arising from an unskilful determination of latitude. The limits of the United States were first laid down in the provisional treaty of 1782. In the second article that part of the northern boundary line involved is specified as follows: —

. . . 'thence through Lake Superior northward of the Isles Royal and Philippeaux to the Long Lake; thence through the middle of said Long Lake and the water communication between it and the Lake of the Woods to the said Lake of the Woods; thence through the said Lake of the Woods to the northwestern point thereof, and from thence on a due west course to the Mississippi River.' . . .

From this it will be seen that although the existence of the Lake of the Woods was definitely known, the commissioners' knowledge of the head waters of the Mississippi River was certainly at fault for want of an accurate map. This fact they recognized, and in 1794 it was ordered that 'the two parties will proceed by amicable negotiation to regulate the boundary line in that quarter.' The 'amicable negotiations' were not resumed, however, until 1818. The treaty made at this time stipulated as follows: —

'It is agreed that a line drawn from the most northwestern point of the Lake of the Woods along the 49th parallel of north latitude, or if the said point shall not be in the 49th parallel of north latitude, then a line drawn due north or south as the case may be, until the said line shall intersect the said parallel of north latitude, and from the point of such intersection due west . . . to the Stony (Rocky) Mountains.'

But subsequent surveys showed that the northwestern point of Lake of the Woods was not on the 49th parallel, but twenty-six miles north of it. So when the survey was continued westward, it was begun at a point twenty-six miles south of the northwestern point of the lake. An inspection of the map of Minnesota in nearly all of the geographies will show that this offset does not apparently reach to the extreme northwestern point of Lake of the Woods. The maps, however, are not in the wrong. The extreme

northwestern part of the area of water generally charted and included under the name of Lake of the Woods is called Lake of Shoals — hence the apparent discrepancy.

No Man's Land. — So much has been said about the strip of public land known variously as the 'Neutral Strip' or 'No Man's Land,' that it becomes a matter of interest to learn how this body of land, one-fifth larger than the state of Connecticut, is without law, government, or any restraint except that which public opinion upholds. Practically this area is as much beyond the jurisdiction of statutory law of the United States as though it were a part of Central Africa. Let us see how this condition of affairs came about.

Formerly No Man's Land was a part of Mexico; but when the Texans threw off the Mexican yoke and established the Republic of Texas, this strip was a part of the new republic; it was never, however, a part of the *state* of Texas. The Indian Territory was formed in 1835–37, and its western limit was then the western limit of the United States, but it should be remembered that the western boundary of the United States was the 100th meridian; beyond that meridian the territory belonged to Mexico, and it so remained as Mexican territory until the close of the Mexican war. When the Indian Territory was formed, it provided that the 'outlet of the Cherokee nation should be a free and unmolested ground reaching to the western boundary of the United States'; but as the territory of the United States extended only to the 100th meridian, the boundary of the Cherokee nation could not extend beyond it. This fixed the western boundary of the Indian Territory, and the eastern boundary of No Man's Land.

With the admission of Texas to the United States, there was a certain difficulty to avoid. The line north of which slavery was not permitted to exist was the parallel of 36° 30′, while the northern boundary of Texas extended to the 37th parallel. Rather than to lose the privilege of slave-holding, the Texans voluntarily ceded to the United States all land north of 36° 30′. This fixed the southern boundary of No Man's Land.

But at this time all the territory north and west of Texas was

unorganized, and embraced a very wide area. When, in 1854, the Kansas and Nebraska bill came up before the United States Senate, it was proposed to make the parallel of 36° 30′ the southern boundary of Kansas, but Senator Stephen A. Douglas, under the supposition that the 100th meridian was not the treaty limit of the Indian Territory, secured an amendment to the bill, making the parallel of 37° the southern limit of Kansas, in order not to deprive the Cherokees of land which it was supposed belonged to them. So a part of the northern boundary of No Man's Land was fixed; and when Colorado Territory[1] was formed, its southern limit of 37° fixed the rest of the boundary. Following closely upon this, the territory of New Mexico was organized, and its eastern limit of the 103d meridian fixed the western boundary of the Neutral Strip.

And thus a large tract of land has been left entirely without the pale of the law, for the jurisdiction of each United States court is limited by political boundaries, and no court can take cognizance of crime beyond its jurisdiction. Therefore No Man's Land with its population of 10,000 people is wholly without protection of life and property except that which is offered by the revolver and the Winchester rifle.

The 'No Man's Land' of Texas. — On account of an error in the treaty surveys there is a tract of land, about 2400 square miles in area, or half the size of Connecticut, lying between Texas and Indian Territory, the ownership of which cannot be determined without special Congressional legislation. This area lies against the eastern part of the 'pan-handle' of Texas, between the North and the South, or Prairie Dog-town Fork of Red River. Politically it is known as Greer County, and, although not recognized by the United States authorities, it is claimed and included by the state authorities of Texas as a legitimate part of that state, and the inhabitants enjoy the same political rights as those of any recognized part of the state.

[1] When Kansas was first organized, the territorial limits extended westward to the base of the Rocky Mountains.

Indian Territory is a part of that tract of land purchased from France, known as the Louisiana purchase, and it is safe to say that neither Uncle Sam nor the king of Spain possessed any accurate knowledge of the topography and drainage of the country. The treaty of 1819 stipulated that —

'The boundary line between the two countries west of the Mississippi River shall begin on the Gulf of Mexico at the mouth of Sabine River in the sea, continuing north along the western bank of that river to the thirty-second degree of latitude, thence by a line due north to the latitude where it strikes the Rio Roxo of Natchitoches, or Red River, then following the course of the Rio Roxo westward to the degree of longitude one hundred west from London (Greenwich) and twenty-three from Washington, and then crossing said Red River and running . . . north to Arkansas River. . . . The whole as laid down in Melish's map of the United States, published at Philadelphia, improved to January 1, 1818.'

Now Melish's map not only locates the 100th meridian about eighty-two miles too far to the eastward, but it also places Red River too far south by about fifty miles. The latter error has not as yet resulted in controversy, but the former has caused no end of trouble. When the 100th meridian was finally located in its proper place, it left matters in a state of delightful uncertainty. About fifty miles to the eastward Red River forks, one of the tributaries coming from the northwest, the other from a point almost due west. Which of these forks is the main stream, it is impossible to decide. South, or Prairie Dog-town Fork has the wider flood-plain; North Fork is more permanent, and contains a larger volume of water. Melish's map shows that the treaty could not have contemplated either fork, and this is about the only thing that his map does show with certainty. He innocently admits that he had neither seen nor surveyed the region in question, saying that the country west of the Mississippi River had been delineated from Pike's explorations. As a matter of fact, however, Pike never visited the region in dispute.

Certain it is the existence of North Fork was known before Melish's map was compiled, and this is considered a strong argument in favor of the claim of Texas. An examination of the terms of the treaty, however, shows that this is not a factor in the dispute, as the treaty was based, not upon the actual facts of the case, but upon Melish's map. Inasmuch as this map ignored the existence of either fork of the river, the question of the boundary can be settled only by an agreement between the United States and Texas.

The Boundaries of Kansas, Nebraska, and Dakota. — Probably the majority of students who have consulted recent maps of Kansas, Nebraska, and Dakota have noticed that the western boundaries of these divisions extend a little beyond the 102d and 104th meridians respectively. On small section maps the difference is so slight that the overlapping can be shown only by considerable exaggeration, but on state maps it is very noticeable. The discrepancy came about by carelessness in the act whereby these divisions were organized. Under this act the boundaries were set, not on the 102d and 104th meridians, but 25° and 27° respectively, west of Washington, probably on the erroneous supposition that this meridian was exactly 77° west of Greenwich. As a matter of fact, the meridian of Washington is 77° 3′+ west of the prime meridian, and it became necessary therefore to relocate these boundaries about two and a half miles west of their former location.

The Boundaries of Europe. — It is a somewhat grim satire on our text-books that an important change in boundary should not be noted for many years after its establishment; but such has been the case concerning the political boundaries of Europe. The Ural Mountains and Ural River are not the boundaries which separate Europe and Asia, except along a very small part of the line. In about latitude 62° the boundary makes a wide detour east of the summit of the Ural Mountains, and in about latitude 52° it passes to the westward of the Ural River. The Caucasus Mountains are not the southern boundary: on the contrary, the latter is for the greater part an arbitrary line about two hundred miles south of this range. The frequent changes in the boundaries

between these grand divisions at least show the inconsistency of attempting to make any physical distinction between the areas usually called Europe and Asia. Why not, therefore, consider the whole Russian Empire as a unit instead of separating it into Russia in Europe and Russia in Asia?

Terminal Capes. — It is quite frequently the custom to drill classes in the terminal capes or points of the various grand divisions. Whether or not time spent in this kind of work is profitable, is hardly a subject for discussion in these pages; but it goes without saying that, if done at all, it should be correctly done. In not a few instances these are incorrectly taught. In at least one handbook it is boldly asserted in the text that Cape Mendocino is the western cape of the United States (exclusive of Alaska). A casual glance at a map of the Pacific coast of the United States will readily show that Cape Flattery is considerably west of Cape Mendocino in longitude. The error in this instance arises from a careless habit of estimating longitude from the margin of the map instead of by meridian distance. The eastern point of the United States is Quoddy Head, Maine. The 49th parallel does not mark the extreme northern part of the United States, inasmuch as a part of Minnesota extends twenty-six miles north of this parallel. The southern extremity is practically the coral reef on which the city of Key West is built. The southern cape on the mainland of Europe is not Cape Matapan, but Cape Tarifa. Even as eminent an authority as the Encyclopædia Britannica is in error here. The southern cape of Asia is not Cape Roumania, but Cape Buru. The western cape of South America is Point Pariña, and not Cape Blanco. Cape St. Roque is not the eastern cape of South America. This distinction belongs to Cape Augustinho, which is rarely shown except on pilot charts. As a matter of fact, this cape is mentioned as a prominent headland in the narrative of Robinson Crusoe. Cape St. Roque, however, is important as marking the bend in the coast from southeast to southwest. Cape Blanco and not Cape Bon is the northern cape of Africa. Cape Agulhas and not Cape of Good Hope is the southern cape.

APPENDIX.

Measuring Ocean Currents.[1]—The Gulf Stream and the currents of the ocean generally were and still are a bone of contention among navigators and scientific men. It had been the practice to study deep currents by attaching a sinking body to a float by the desired length of line, and committing the whole to the sea. What was taking place below was inferred from what could be seen to be taking place at the surface. Methods so uncertain could produce but uncertain results.

It seemed to Lieutenant Pillsbury that there was but one way to grapple with this problem, and that was to anchor the investigating vessel, and from it to send down to the required depth some machine which would automatically record exactly what was taking place there. Now to anchor in 50 or 60 fathoms of water was at that time rather unusual, but to anchor in 1000 or 1500 fathoms, as his plan contemplated, was altogether unheard of. It was a bold project; but he thought over the apparatus which would be required, and, convinced that it ought to work, went at it. An old deep-sea dredging apparatus furnished most of the material, and this he modified, rearranged, and added to, to control his cable. At the same time he invented and constructed a current metre which not only accurately and automatically records the velocity of any current in which it may be placed, but its direction as well. This ingenious instrument may be thus briefly described. A rudder or vane forces the four little cones to face the current; they revolve, and a counting-machine registers the number of revolutions. A compass, attached just above the

[1] From a paper by Henry Wells, used with the permission of Harper & Bros.

sinker, acts as compasses do, and of course the rudder or vane makes the same angle with its needle that the current makes. The first movement to hoist the machine locks the compass and the van or rudder. This fixes the direction of the current. When on deck, the register is read, the proper allowance for motion in ascending and descending to the given depth is deducted, and then by reference to a table deduced from experiment the velocity of the current is accurately determined.

The anchor used is what is known as a 'Cape Ann fisherman's anchor,' of about five hundred pounds weight. The cable is of hard steel wire rope of the very best quality. It is 3700 fathoms long, and half an inch and less in diameter. The entire cable is reeled in and paid out from a large reel between decks, but the work of hoisting up the anchor and controlling its descent is done by a powerful hoisting engine on deck.

Anchoring in the sea itself, where the water is in a condition of almost chronic turmoil, must require peculiar appliances to arrange for the pitching of the vessel, especially in so small a one as the *Blake*. To run the cable out of a hawser hole in the bow, as is the usual practice, would not answer at all. Lieutenant Pillsbury arranged it thus: he projected a very strong boom from the bow, carrying an iron pulley two feet in diameter, over which the cable passed on its way into the sea. The outboard end of this boom was topped up at an angle of about 35° by a strong rope called a 'topping-lift,' which led to the foremast head. The pitching of so small a vessel in a seaway is tremendous. The vessel must rise to each sea, and each rise must bring a sudden and heavy strain upon the cable. To meet this contingency, Lieutenant Pillsbury interposed between the 'topping-lift' and the foremast-head thirteen feet of rubber disks strung on a steel rod. All the strain on the topping-lift was transmitted to the steel rod. The whole device, called the 'accumulator,' was so arranged that upon a sudden increase of strain the rubbers were compressed, thus lengthening the topping-lift, and permitting the end of the boom which sustains the cable to bow down. When the strain ceases,

the elasticity of the rubbers elevates the outer end of the boom to its original angle. In practice the 'accumulator' is allowed to be compressed 4½ feet, when a second topping-lift takes up the strain.

In anchoring in 'shallow water,' as Lieutenant Pillsbury calls 500 or 600 fathoms, the anchor is let go, and cable is fed to it at the rate of about 50 fathoms, or 300 feet, a minute. But in greater depths, if unknown, a sounding is first made. The anchor is then lowered away, at the rate indicated above, till near the bottom. Then it is let down the rest of the way more slowly, for fear the cable may foul the anchor. Though the wooden stock of the anchor is driven in as tight as possible, it comes up quite loose, and with every difference in the hardness of its surface marked by the tremendous pressure to which it has been subjected.

After the anchor has taken the bottom, preparations are made to lower the current metre. The following description will make clear the method followed. The anchor having grappled bottom, the fast end of the cable toward the vessel is almost perpendicular for a long distance below the surface. Advantage is very ingeniously taken of this to retain the current metre in a fixed position in relation to the current. A wire called a 'jack-stay' is fastened to the anchor cable, and after that both are paid out together. Seven or eight hundred fathoms of cable in excess of the depth is all the 'scope' ever given. To keep the 'jack-stay' straight up and down, 300 pounds of iron are attached to its lower end. Also the jack-stay is connected to the anchor cable by an intervening piece of rope, proportioned to the strength of current and depth of water, so that the jack-stay may be perpendicular. Upon this jack-stay the current metre, provided with its own hoisting wire and 75 pounds of sinker, is sent down and hauled up as often as may be desirable.

Lieutenant Pillsbury tried his invention for the first time in March, 1885. But few changes have been found necessary in the apparatus. He has remained three days at anchor in 1000 fathoms, — 6000 feet, — and from morning till night at anchor

in 1852 fathoms, or 11,112 feet. This last was his deepest anchorage. He was forced to get under way by the approach of a very heavy squall. At this depth 45 minutes was sufficient to anchor the vessel, and 1 hour and 15 minutes was required to heave the anchor up. It now remains to set forth the practical advantages which have already flowed and which may be expected to flow from this work. They are indeed great. Bad weather is the time of danger at sea. Aside from stress of wind and wave, the mariner cannot then check his position by observation. He knows the direction in which he is headed and the rate at which he is passing through the water, and from these he computes his position. But there is always one uncertain factor, which may make or mar him, and for which he cannot allow. It is the current. He may calculate the rate and direction in which he is passing through the water correctly enough. But the rate and direction in which he is passing over the bottom, and consequently approaching the land, may be quite another thing. Probably a very large majority of all the wrecks which annually occur on the more frequented coasts of the world are due to this cause. Any investigation which may tend to help the mariner to this all-important information, whether viewed from a humanitarian or from a pecuniary standpoint, should receive the warmest encouragement. Lieutenant Pillsbury's work has already accomplished much in this direction, though, at the present time, but in its infancy, so to speak.

He anchored his vessel at various places, and at various depths up to 1150 fathoms, on a line between Yucatan and Cuba, and sent down his current metre to question the Gulf Stream. He continued his observations in various places and at various depths up to 1024 fathoms, on a line between Key West and Cuba, and again questioned the Gulf Stream with that valuable invention. He occupied a third line across its course between the southern end of Florida and the Bahama Bank, and there repeated his investigations. He found that the current of the Gulf Stream — the most important to the welfare of mankind, and the most stud-

ied of the currents of the oceans — was influenced by the position of the moon; that it increased in velocity up to a certain point and then diminished, as rhythmically and frequently as the ebb and flow of the tides. And he furnished data which enabled the Coast Survey to inform mariners using these frequented and dangerous thoroughfares just how they could tell at any hour, day or night, at any month of any season, just what currents they might expect to encounter. The one heretofore uncertain element which entered into the calculation of their position otherwise than by observation was made certain. Sea-captains, conferring together, would not unfrequently find that one had had a tremendous current for or against him, while another, in the same place but at another time, had found but a feeble flow. But this was supposed to be a chance effect due to fortuitous causes. That it was a regular phenomenon governed by fixed laws was not even dreamed of by those most versed in this much-studied stream.

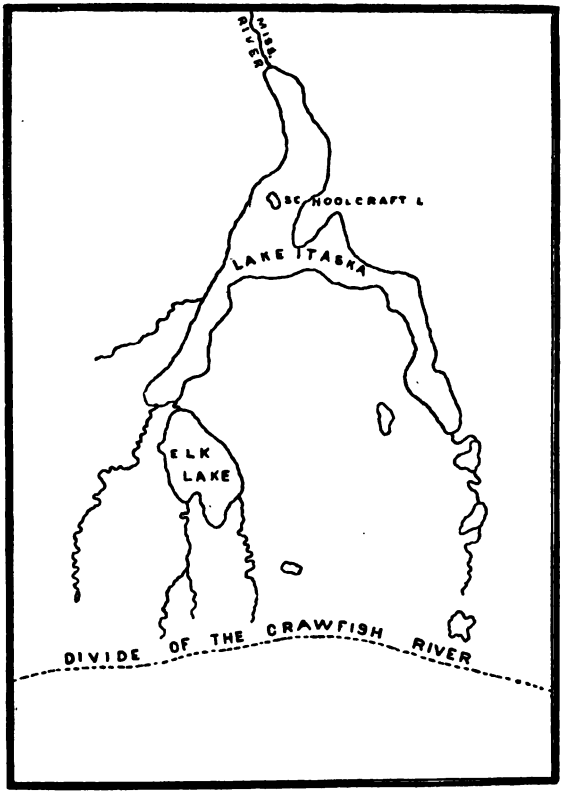
If a discovery of such scientific interest and great practical value has followed almost upon the first application of Lieutenant Pillsbury's methods and devices to this work, what may we not hope from them in the future? In the near future the *Blake* will first visit the 'Horse Latitudes' — the region between the trade-winds and the variable winds of the North Atlantic. This will involve several anchorages in 2500 fathoms, or 15,000 feet, of water, yet he seems to entertain little doubt of success. He will then endeavor to determine whether any current exists outside of that due to the trade-winds themselves, and will make a series of observations northeastly of Nassau, N.P., with a view of determining how much the stream which leaves the Gulf of Mexico is augmented by the general ocean circulation passing to the northward of the Bahamas — a problem the solution of which may quite probably revolutionize existing views as to the extent and character of the Gulf Stream proper, and its influence on the climatology of Europe. Then anchorages will be made on the coast of South America, just outside of the Windward Islands, to ascertain the approximate value of the north branch of the great equatorial cur-

rent. Then the passages between the West India Islands will be occupied, and the currents which enter the Caribbean Sea from the Atlantic will be gauged. This will probably determine the amount of water-flow caused by the trade-winds. The practical value of a sound knowledge of those currents, from a pecuniary and a humanitarian point of view, has already been indicated. Aside from this, Lieutenant Pillsbury's work this coming winter will certainly throw great light upon, if it does not completely solve, questions which have puzzled scientists from the days of Columbus to the present time.

The Source of the Mississippi. — Within a few years there has been much agitation as to what particular body of water constitutes the true source of the Mississippi River. As the matter now stands, there are two lakes holding rival claims to this honor. One of these, Lake Itaska, until recently has had the undisputed possession to the title for about fifty years. The other, which appears on certain maps, including the United States Land Office publications, as Elk Lake, and on certain other maps as Lake Glazier, is at present the subject of a bitter dispute.

In 1881 Captain Willard Glazier visited the head waters of the Mississippi, and entered the small lake to the south of Lake Itaska. In honor of the expedition, his friends christened the body of water Lake Glazier. From this reservoir, Glazier with his party journeyed the entire length of the river to South Pass, and there seems no doubt that his is the first party that ever did so. At first it was claimed that Captain Glazier was the discoverer of the lake, but inasmuch as the latter was located and measured by the surveyors who compiled the Land Office map of the northern part of Minnesota, two years prior to his visit, the claim of first discovery was relinquished by Captain Glazier. Schoolcraft, who explored the region in 1834, notes the lake on his map, though he makes no mention of it as the source of the Mississippi. Nicollet also explored the region in 1843. Nicollet's map does not closely resemble Schoolcraft's, nor any of the recent maps. He, however, speaks of the various streams entering Lake Itaska. Of one of

these he says, 'so that, in obedience to the geographical rule that the sources of a river are those which are most distant from its mouth, this stream must be the infant Mississippi.'



The Source of the Mississippi.

Captain Glazier's account was the first to call general attention to the position and importance of the lake in question. Whether it shall continue to be called Elk Lake or Lake Glazier, is a matter

which custom only can decide. The Geological Survey and the Land Office adhere to Elk Lake. The new edition of the 'Encyclopedia Britannica' has adopted Lake Glazier as the name. Whether Elk Lake or Lake Itaska is to be considered the true source, is largely a matter of opinion. Some of the leading geographers of the country adhere to Lake Itaska, but the size and depth of the lake to the south of Lake Itaska is certainly entitled to consideration, and in view of the opinion of Nicollet, quoted above, there can be no objection to considering this lake the prime source of the river.

The Gulf Stream as a Factor in Climate. — The following letter represents the opinion of one of the leading hydrographers of the United States Coast Survey. It contains information not previously published.

U. S. Coast and Geodetic Survey Office,
Washington, Aug. 27, 1888.

Hon. JOHN HANCOCK, *Austin, Tex.*

DEAR SIR: — I beg to acknowledge receipt of your letter of July 24, which would have received earlier attention but for my absence for a short time from the office, and the great press of business which awaited me upon my return.

The subject of the Gulf Stream is one which has claimed the attention of physicists from the days of Columbus to the present time. They have one and all theorized without any really definite information even about the surface flow, not to mention the sub-currents, upon which to base their (in many instances) far-fetched conclusions. Beyond a doubt there is a stream of water flowing out between the capes of Florida and the Bahama Islands at a maximum velocity of about four miles per hour, and a minimum of about one mile per hour, and varying in temperature from 82° at the surface to about 50° at 475 fathoms — 2850 feet — where we strike bottom.

Now it is a commonly accepted theory that this water, at this temperature, flowing at this velocity, warms up the whole north-eastern Atlantic Ocean, including the coasts of England, Scotland,

and Norway; but was there ever anything more absurd? The whole of the water passing out of the straits of Florida, and commonly looked upon as the Gulf Stream, could not (in my opinion), if it were of the uniform temperature of 82° down to the bottom, produce a tithe of the effect claimed for it. The fact is that the whole of the water passing north through the Straits of Florida is in about the same proportion to that required to produce known effects in the Northeast Atlantic as the water of the Kanawha River in West Virginia is to the Mississippi.

We have in the Atlantic Ocean a great Sargasso or grassy sea, and the same phenomenon exists in the Pacific, in relatively the same situation. Here are Nature's indications of two great oceanic eddies formed by similar agencies. That the one in the Pacific is formed by a great movement of warm surface water in a northeasterly direction, which warms up the coasts of Alaska, of British Columbia, and of the United States, no one will deny; but it has no Gulf of Mexico to act as a great stand-pipe as is supposed to be the case with that in the Atlantic, yet we have precisely the same climatic conditions upon the northwest coast of America as upon the northwest coast of the Eastern Hemisphere.

I make these remarks for no other purpose than to invite your thought and attention to the great probability of there being much false speculation in regard to what we have considered as the results of our Gulf Stream.

So much for the Gulf Stream in general as regards its probable effect upon the northeastern Atlantic Ocean. Now, for a particular consideration of anything in this phenomenon which would be likely to affect harbors on the coast of Texas. I am myself of the opinion that the waters in the Gulf of Mexico are slightly higher than those in the Atlantic Ocean, at St. Augustine, Fernandino, or at Gun Cay, but I am certainly not prepared to say that it is higher, to any appreciable extent, than the waters of the Atlantic at New York or Boston. Such information as we have, based upon a single line of precise levels, indicates no such thing. If we substitute for our line of precise levels from Sandy Hook to St.

Louis a line of levels up the Hudson and thence to Great Lakes, and thence water levels of the surface of the lakes with some intervening instrumental work between Chicago and St. Louis, we get the Gulf three feet higher than the ocean at Sandy Hook, but whoever in the present state of observed facts ventures to assert that we have any data to uphold the statement that you quote (28 inches) must throw away, deliberately, our best information. Until the check lines of this work are entirely completed I am not prepared to say, nor would I venture a guess, at the difference of level between the Gulf and the waters at New York, although I have known some eminent scientific men who were fond of prattling on this subject.

That the water which flows around the capes of Florida and out along its eastern coast, and which we commonly accept as the Gulf Stream, is supplied from the Caribbean Sea and around the west end of Cuba, we have ample proof gathered within the past three years, including the deep-sea current observations just made. That there is some circulation of warm water in the Gulf of Mexico, I am not prepared to deny. If so, it is simply a circulation, and not a very strong current flowing continuously in one direction. In our hydrographic work which covered the Gulf of Mexico (I here allude to ordinary surroundings taken for chart making) no well-defined current was ever noted, although currents from 1 to $2\frac{1}{2}$ knots per hour were frequently found, but they were running on different days and at different places to all points of the compass. So much so, in fact, that it was decided not to attempt to indicate them in our charts, on the ground that false information is worse than no information, for it seemed clear that north current to-day would be south current to-morrow. Had I under consideration the building of a harbor on the coast of Texas, I should not expect either assistance or retardation of my projects from anything like a Gulf Stream sweeping along the coast. On that assertion I can safely risk my reputation. Your remark as to our inadequate knowledge (and I do not speak of speculation, but of solid facts) is certainly very appropriate. The

question of the ocean currents is one that should demand close attention from our people. It is scarcely ten years since the problem of anchoring vessels in the deep sea was successfully solved, and the apparatus devised with which to measure the direction and velocity of the currents from the surface to the bottom, and the temperature of the same is of even a much later date. When a great and all-absorbing problem, like that upon which you are now engaged, is to be solved, we all feel the need of the information, the road to which now lies open before us, but the means for pursuing it are very limited. Instead of ten or a dozen ships, equipped and supplied for this purpose and anchored simultaneously along the great highways of commerce over the seas, with an appropriation of $100,000 for their support and maintenance, we have one ship with an appropriation of $8000 grudgingly bestowed. Only partial results can be obtained in this manner, and they will come to us slowly.

You doubtless have Coast Survey Reports for 1885 and 1886 which contain appendices by Lieutenant J. E. Pillsbury, U.S.N., assistant in the U. S. Coast and Geodetic Survey, commanding the Coast Survey Steamer *Blake*. With the facts set forth in these Appendices there begins an era in explorations and discovered facts concerning the Gulf Stream (as we call it) and other oceanic currents from surface to bottom, which may, some of these days, induce the leading maritime powers of the world to unite in a series of simultaneous and long-continued observations of currents in mid-ocean, if our own government persists in refusal, which cannot fail to be of vast importance to mankind.

Yours respectfully,

(Signed) B. A. COLONNA,

Assistant in Charge of the Office.

Crusoe's Island.—The island of Juan Fernandez, or Massa Tierra, is dear to the heart of every schoolboy because of its alleged connection with the story of Robinson Crusoe. It is a

delightful strip of land thirteen miles long and four miles wide, situated about 400 miles west of Chili. Its fame is due to the enforced residence of Alexander Selkirk, a Scotch sailor, whom, it is asserted, De Foe made the hero of his famous story.

A study of the story, however, can but lead to the conclusion that Selkirk was not the character whose misadventures are related therein, and that the wrecking of the vessel took place — not in the Pacific Ocean, but on one of the Windward Islands, about ten leagues northeast of the Island of Trinidad.

In the account of the casting away of the ship Crusoe says: "About the twelfth day (of the storm), the weather abating, the master made an observation as well as he could and found he was in about eleven degrees north latitude, but that he was twenty-two degrees of longitude difference from Cape Augustinho (the extreme western cape of Brazil, near the town of Parahyba), so that he found he was upon the coast of Guiana, or the north part of Brazil, beyond the river Amazons, towards that of the Oroonoque (Orinoco), commonly called the Great River, and began to consult with me what course he should take, for the ship was leaking and very much disabled, and he was going directly back to the coast of Brazil.

"I was positively against that, and looking over the charts of the sea-coast of America with him we concluded there was no inhabited country for us to have recourse to till we came within the circle of the Caribbee Islands, and therefore resolved to stand away for Barbadoes, which, by keeping off at sea to avoid the indraft of the bay or Gulf of Mexico (probably the Gulf Stream), we might easily perform, as we hoped, in about fifteen days' sail. . . . With this design we changed our course and steered away northwest by west in order to reach some of our English islands, where I hoped for relief. . . . When being in the latitude of twelve degrees and eighteen minutes N. a second storm came upon us. . . . In this distress, the wind still blowing very hard, one of our men early in the morning cried out, 'Land!' and we had no sooner run out of the cabin to look out, in hopes of seeing where-

abouts in the world we were than the ship struck upon the sand." Then follows the description of the fatal wreck of the boats and the landing on the lonely island which for so many years was the home of Crusoe.

Here we have a detailed account of the locality of the ship and of the storm, which was evidently one of the cyclones so common in the Caribbean Sea. Now in order to have reached the island of Juan Fernandez the ship must either have been carried across South America in the broadest part, or else have been swept around the entire continent, a distance of 10,000 miles, in about ten hours. But no such supposition is necessary to carry out the story, for the island of Tobago, now a thriving British colony, meets all the requirements of the position and bearings of the wreck.

The shores of this island are washed by a current of the great river Orinoco, and its latitude, longitude, and bearings from the locality in which the master took his observations correspond so closely to the locality of Tobago that the considerations of any other is out of the question.

At a time when Crusoe was in mortal terror of being killed by the cannibals who occasionally visited Tobago he was made happy by the discovery of a cave, which he used as a place of refuge and concealment. In Lieutenant Cappadose's 'Sixteen Years in the West Indies' the author describes a cave on the southwest coast of the island under a headland named Crown Point, which lies opposite the island of Trinidad. The cave is about twenty feet long, half as broad, and of a height sufficient to permit a tall man to stand upright. 'At the extreme end is an aperture only large enough to admit a very small animal.'

By comparing this with De Foe's description it will be seen that the two agree as to position and general dimensions. The aperture which Cappadose believed by common report to be 'of considerable extent,' Crusoe explored and found that it led to a second cave. Crusoe soon found herds of wild goats on the island, and it is a noteworthy fact that these wild animals were formerly abundant there. He also found sea-fowls in abundance,

and even to the present day the islands of this group are rookeries for myriads of them. Crusoe mentions the killing of a huge turtle, and tortoises answering to the description are numerous.

In coasting about the island on his raft Crusoe found the estuary of a creek up which the tide ran a distance of two miles. The estuary was bordered with 'many pleasant savannahs, or meadows, plain, smooth and covered with grass; and on the rising parts of them (the terraces) next to the higher ground' he 'found a great deal of tobacco.' The next day, going somewhat further than he had the day previously, the savannahs gave place to a wooded country, where he found fruits, 'particularly melons, on the ground, and grapes in great abundance.'

He also mentions incidentally, that he discovered large 'plants of aloes, but did not understand them,' and 'several sugar-canes.' Crossing the ridge of hills, he descended into a vale, where there was 'an abundance of cocoa-trees, orange, lemon and citron (lime) trees.'

Now all these items describe the flora and fauna of Tobago and the other islands near by, and it would hardly be an exaggeration to say that in not a single circumstance do they describe the island of Juan Fernandez. The two rainy seasons of Tobago, according to Crusoe, were from August to October, and from March to May. This corresponds to the climate of the Windward Islands, but not to that of Juan Fernandez, where the rainy season occurs in June, July, and August.

The furious currents which Crusoe describes on the coast of Tobago are confirmed by the Admiralty charts. The cannibals, whose occasional visits gave Crusoe so much distress and fear, were none else but the Caribs, and no such people are found on the Chilian coast. Indeed, if there were, it would hardly be credible that they would attempt a canoe journey of 400 miles for the sake of making a cannibal feast.

Furthermore, Alexander Selkirk was not wrecked, but was put ashore on the island for mutinous conduct, while Crusoe was shipwrecked.

Now, the most savage critic of De Foe's story of 'Robinson Crusoe' would not for a moment assert that it was a creation of the author's imagination. An author like De Foe certainly could create a story equally marvellous as that of Crusoe, but it would not be consistent in itself. A landsman without a nautical education would be as helpless in dealing with the technicalities of navigation as a sailor in discussing the ethics of theology. No, the real author of the story was a man of fair education, who was born to the sea. In other words, De Foe's conception is based upon a true story, minutely and elaborately told.

There is a marked difference, however, between the Crusoe of the first part of the narrative and the Crusoe of the continuation or second part, and not even the skill of De Foe can divest each character or narrator of his individuality. The second part may possibly be a fiction; the first part is not — it would be simply an impossibility for the most vivid imagination to conceive a story so correct and so consistent in its details and true in its geographical description.

The only inconsistent statement in the narrative is strongest evidence of its genuineness. Crusoe asserts that after being tossed about in the storm several days — a cyclone, by the way — the ship was in distress and leaked badly. The master was for putting back to the Brazilian coast, but Crusoe counselled going to Barbadoes. So the ship's course was changed to northwest by west, and after a few hours' sail a *second* storm overtook them.

Now, if we examine a mariner's chart we shall find that the vessel was in a region of cyclones during the season when such storms are prevalent. Furthermore, the direction of the cyclones in this region is northwest by west. Therefore what Crusoe describes as taking place must of necessity have occurred. He states the facts of the case correctly, but misinterprets them when he declares that they were overtaken by a *second* storm. What they really did was to steer the vessel back into the same storm from which they had just escaped. De Foe could not possibly have jumped upon this incident of the narrative by accident. — J. W. R. (*Philadelphia Times*).

The Orthography of Bering's Name. — There is a very persistent error in the spelling of the name of the bold Danish navigator and discoverer, made famous by his work in the Arctic Ocean and along the shores of Alaska. The incorrect form *Behring* is now so firmly fixed that but few writers use the correct form *Bering*. Within a few years, however, the original form has been growing in favor. The following communication gives all necessary evidence in the case: —

U. S. Coast and Geodetic Survey,
Washington, Jan. 26, 1885.

Prof. J. W. REDWAY, *New York City.*

DEAR SIR: — In regard to the orthography *Bering*, as used in the Coast Survey and other government publications, I beg leave to state that your letter furnishes its own answer, viz., Commander Ivan Ivanovich Bering uniformly spelled his name *Bering*, as do his descendants now living in Denmark. The erroneous form *Behring*, first introduced in the second decade of the present century, has become so thoroughly fixed in popular English and American usage that the restoration of the original and correct form, particularly in text-books and hand-books, progresses very slowly. Special students of Alaska steadily adhere to the correct form *Bering*, and I take occasion to congratulate you in the attempt to spread the correct form before a large and increasing audience. Common errors are corrected only with great difficulty.

Very respectfully,

J. E. HILGARD,
Superintendent.

GEOGRAPHICAL READING.

WITH the multitude of books of travel that are poured out upon the public from a score of publishing houses, there should be no dearth of reading. Books of sterling value, however, are not numerous; and many very popular books, while they are fascinating because of their vivid word painting, are worthless so far as geographical merit is concerned. The following list might easily be expanded many times its present length, but it is doubtful if its value would be materially increased.

BOOKS EVERY TEACHER SHOULD OWN.

The latest series of text-books on geography.	
Primer of Geography. *Grove.*	Appleton & Co.
Elementary Physical Geography. *Geike.*	" "
First Book of Geology. *Shaler.*	D. C. Heath & Co.
Astronomical Geography. *Jackson.*	" "
Comparative Geography. *Karl Ritter.*	Van Antwerp, Bragg & Co.
Typical Studies in Physical Geography, — a series of photographic views.	D. C. Heath & Co.
Geography, Historical, Physical, etc. *Johnston.*	Stanford.
Earth and Man. *Guyot.*	
Child and Nature. *Frye.*	Hyde Park Pub. Co.
Pocket Atlas of the World.	Ivison, Blakeman & Co.

METHODS OF TEACHING GEOGRAPHY.

Child and Nature. *Frye.*	Hyde Park Pub. Co.
The Teaching of Geography. *Geike.*	Macmillan.
Methods of Teaching Geography. *Crocker.*	Boston Supply Co.
How to Study Geography. *Parker.*	Appleton & Co.
How to Teach Geography. *Carver.*	
Teacher's Supplement to First B'k of Geol. *Shaler.*	D. C. Heath & Co.
Methods and Aids in Geography. *King.*	Lee & Shepard.

Elements of Pedagogy. *White.*	Van Antwerp, Bragg & Co.
Topics in Geography. *Nichols.*	D. C. Heath & Co.
How to Use Globes. *Brownell.*	Andrews & Co.
Essentials of Geography. *Fisher.*	
Talks on Teaching. *Patridge.*	Kellogg & Co.
Manual of Methods. *Hopkins.*	Lee & Shepard.

General Works of Reference.

Encyclopædia Britannica.
Johnson's Cyclopedia.
New American Cyclopedia (with supplements).
Lippincott's Gazetteer.
Stanford's Compendium of Geography and Travel. 6 vols.
Keith Johnston's Geography, Historical, Physical, and Descriptive.

Dana's Geology.	Ivison, Blakeman & Co.
Le Conte's Geology.	Appleton & Co.
Geike's Geology.	" "
Dictionary of Altitudes. *Gannet.*	U.S. Geol. Survey.
Boundaries of the States and the United States. *Gannet.*	" "

Special Works of Reference, — Physical Geography.

The Earth. *Élisée Reclus.*	Harper & Bros.
The Ocean. *Élisée Reclus.*	" "
Physical Geography of the Sea. *Maury.*	
Elementary Physical Geography. *Geike.*	Macmillan.
Physiography. *Huxley.*	Appleton & Co.
Cosmos. *Humboldt.*	
Volcanoes. *Judd.*	Appleton & Co.
Earthquakes. *Milne.*	" "
Forms of Water. *Tyndall.*	" "
Weather. *Abercromby.*	" "
American Weather. *Greely.*	Scribner & Co.
Great Ice Age. *James Geike.*	Appleton & Co.
Climate and Time. *Croll.*	" "
Geological Survey of Idaho and Wyoming. *Hayden.*	U.S. Geol. Survey.
The Geological History of the Grand Cañon. *Dutton.*	" "
Lake Lahontan. *Russell.*	" "
Three Cruises of the Blake. *Agassiz.*	Houghton, Mifflin & Co.

Lake Bonneville. *Gilbert.*	U.S. Geol. Survey.
The Arid Region. *Powell.*	" "
The Ice Age in North America. *Wright.*	Appleton & Co.
Physical Geography. *Somerville, Mrs.*	
Handy Book of Meteorology. *Buchan.*	Longmans & Co.
Depths of the Sea. *Thomson.*	Macmillan.
Coral Islands. *Dana.*	
Physical Geography of the Mississippi River. *Redway.*	D. C. Heath & Co.
Geography of Coast Lines. *Lawson.*	
Geography of River Systems. *Lawson.*	
Climatic Changes of Later Geological Times. *Whitney.*	Little & Brown.
The United States, Physical and Statistical. *Whitney.*	" "

MAPS, ATLASES, AND GLOBES.

Stieler's Atlas (new ed. 1889–90).
Johnston's (Keith) Royal Atlas (new ed. 1888).
Johnson's (Ruddiman) Atlases.
Andree's Atlas (new ed. 1887).

The foregoing are foreign publications. The atlases vary in price from $10 to $40. Of these, Andree's, price about $12, is a marvel of mechanical execution, and is one of the best ever produced. All foreign atlases are defective in American geography.

Bradley's Atlas.	Bradley & Co.
Cram's Atlases.	Cram.
Rand & McNally's Atlas and Shipper's Guide.	Rand & McNally.
Descriptive Atlas.	Ivison, Blakeman & Co.
Appleton's Atlas of the United States.	Appleton & Co.

Of the foregoing, the Descriptive Atlas, price about $5.00, and Appleton's Atlas of the United States, price $1.50, are the most available for teachers' use. The former is a general atlas, very complete in descriptive geography, and with most excellent maps of the states and territories. The latter embraces the states of the United States only, and contains very valuable statistical matter.

There are but few good wall maps published. Those which are respectable in geographical features are generally wanting in pedagogical qualities, and many of those which have been compiled for their pedagogical value are thoroughly disreputable in every other respect. The following are among the better class: —

Berghaus Physical Map of the World, — one of the best ever published.
Guyot's Physical Maps.
Stanford's Wall Maps.
Johnson's (Ruddiman) Wall Maps.
Rand & McNally's Wall Maps.
Andrews' Globes. The 18-inch globe on high stand is a very desirable one. *Johnston (Keith).* Andrews & Co.
Joslin's Globes. D. C. Heath & Co.
The Stellar Tellurian. " "
The Cosmosphere. *Bailey.* Bailey.
Progressive Outline Maps. D. C. Heath & Co.

The last-named maps will be found invaluable in studying geography and history. They may be edited either as physical, political, or historical maps.

Relief Maps, Models, Photographic Studies, etc.

Geological Models and Studies. *Shaler.* D. C. Heath & Co.
Relief Maps of the Continents. *King.*
" " " " " *Frye.*
Relief Maps showing Progressive Effects of Earth Sculpture. *Davis.*
Typical Studies in Physical Geography. *Redway.* D. C. Heath & Co.

The last-named series embraces a large number of photographic studies in orography, earth-sculpture (erosion, corrasion, and sapping), vulcanology (both selenic and telluric), to which will shortly be added photo-relief maps of the continents.

Mathematical and Astronomical.

Popular Astronomy. *Newcomb.* Harper & Bros.
The New Astronomy. *Langley.*

Astronomical Geography. *Jackson.*	D. C. Heath & Co.
How to Use Globes. *Brownell.*	Andrews & Co.
Primer of Astronomy. *Lockyer.*	Appleton & Co.
Traité des Projections des Cartes Géographique.	Germain et Cie., Paris.
Mathematical Geography. *Clarke.*	(In Encyclopædia Britannica.)

EXPLORATION.

Arctic Explorations.	*Kane.*
Open Polar Sea.	*Hayes.*
Arctic Voyages.	*Nordenskiöld.*
In the Arctic Seas.	*McClintock.*
Three Years of Arctic Service.	*Greely.*
African Explorations.	*Livingstone.*
The Voyages of Captain Cook.	*Kippes.*
Stanley and the Congo.	*Packard.*
Australia.	*Fitzgero'd.*

NORTH AMERICA.

North America.	*Hayden and Selwyn.*
Mexico.	*Ober.*
California, Oregon, and the Sandwich Islands.	*Nordhoff.*
Our Arctic Province.	*Elliott.*
Two Years Before the Mast.	*Dana.*
Geological Surveys of Wyoming and Idaho.	*Hayden* (U.S. Geol. Sur.).
Rambles in Wonderland.	*Stanley.*
California of the South.	*Lindley.*
The Great Fur Land.	*Robinson.*
The Apache Country.	*Ross Browne.*
The Great Lone Land.	*Butler.*
The Wild North Land.	"
Publications of U.S. Geol. Survey.	

SOUTH AMERICA.

Capital Cities of South America.	*Curtis.*
Journey in Brazil.	*Agassiz.*
Up the Amazon and Madeira.	*Matthews.*
Chili.	*Boyd.*
Boy Travellers in South America.	*Knox.*

Dutch Guiana.	*Palgrave.*
Argentine Republic and Paraguay.	*Page.*
Peru.	*Squier.*
Adventures in Trinidad and Up the Orinoco.	*Kingston.*
Travels.	*Von Humboldt.*
Forests of Guiana.	*Brett.*

EUROPE.

Guide Books.	*Baedecker.*
'Walks' in London, Rome, Venice, etc.	*Hare.*
Land of the Midnight Sun.	*Du Chaillu.*
Hours of Exercise in the Alps.	*Tyndall.*
Untrodden Spain.	*Rose.*
Picturesque Holland.	*Havond.*
Travels in Greece and Russia.	*Bayard Taylor.*
Northern Travels.	" "
Views Afoot.	" "
Iceland.	" "
Irish Homes and Irish Hearts.	" "
Scotland and the Scotch.	*Sinclair.*
Zigzag Journeys in Europe.	*Butterworth.*
Turkey and the Turks.	*Cox.*
Up the Volga to the Fair of Nijne Novgorod.	*Munro-Butler-Johnstone.*
Austria-Hungary.	*Kay.*

ASIA.

Travels in Siberia.	*Kennan.*
Lands of the Saracen.	*Bayard Taylor.*
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AFRICA.

See also EXPLORATION.

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AUSTRALASIA AND POLYNESIA.

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Australasia.	*Fitzgerald.*
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Across Australia.	*Warburton.*

JUVENILE.

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The 'Rollo' Books (series).	*Abbott.*
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New Way Round the World.	*Coffin.*
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Eyes and No Eyes.	*Barbauld, Mrs.*
Round the World, by a Boy.	*Smiles.*
What Darwin Saw.	
Seven Little Sisters.	*Andrews.*
Each and All.	"
Life and Her Children.	*Buckley.*
Winners in Life's Race.	"
Life in the North.	*Schwatka.*
Alaska's Great River.	"
Little Folks of Other Lands.	*Chaplin and Humphrey.*
Family Flights.	*Hale.*
Fairy Land of Science.	*Buckley.*
Land of the Midnight Sun.	*Du Chaillu.*
Orient Boys.	*Keene.*
Hans Brinker.	*Dodge.*
Sea and Sky.	*Blackiston.*
Little People of Asia.	*Miller.*
The Young Llanero.	*Kingston.*
All Aboard for Sunrise Lands.	*Rand.*
" " " Lakes and Mountains.	"
Up the Tapajos.	*Ellis.*
Lost in the Wilds.	"
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Science for the Young.	*Abbott.*

NEWSPAPERS AND MAGAZINES.

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THESE outlines are for the use of the pupil, and are based on the assumption that map-drawing should be taught as a means, and not as an end; that its purpose is to assist the mind in acquiring and fixing geographical facts, and that to memorize the construction lines of other methods and the hundreds of nameless projections and indentations of a tortuous coast-line is a waste of time and of nervous energy which would be better employed in studying important and interesting particulars concerning the physical features, climate, products, etc., of the interior.

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Expressions from prominent teachers, who have already successfully used these maps with classes for these purposes, indicate a decided preference in their favor, and a positive unwillingness to return to the imperfect outlines constructed by the pupils themselves.

5. **Economy in price.** These maps cost the pupil two cents each. Several times that amount is usually expended for paper required for the practice in producing a satisfactory map by other methods.

DIRECTIONS FOR THE USE OF THE PROGRESSIVE OUTLINE MAPS.

MANY ways of using the **Progressive Outline Maps** will suggest themselves to teachers. A practical teacher who has used them for some time has kindly prepared for us the following directions descriptive of his own method. These directions are for advanced classes, and include the less within the greater.

Teachers in the lower grades can readily modify or omit as the condition of their classes may demand. Colored inks and pencils are recommended.

The great object of the **Progressive Outline Maps**, as of all map-making, is to help the pupils to remember the important facts of geography. Maps should therefore be developed in connection with the subject as it is studied.

One or two lessons are given to the study of the contour of a country from the text-book, and then the **Progressive Outline** is placed in the hands of the pupil.

1. The pupil now traces the outline with pen or pencil, and afterwards reads the same as a lesson in cipher, telling where the country is with reference to zone circles, other grand divisions, and the oceans bordering upon it; also mentioning its general shape, the important projections and indentations.

He next prints their appropriate names, against the features, or, if a member of a lower class, writes them. Two or three short lessons in printing, with a few minutes' practice, will greatly facilitate this work, and enable the pupil to present a nicely made map.

2. After the surface has been carefully studied, the mountains, peaks, and volcanoes are drawn in the map from the text-book, with such changes as the teacher directs. The names of these chains, etc., should be written or printed as they are drawn.

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